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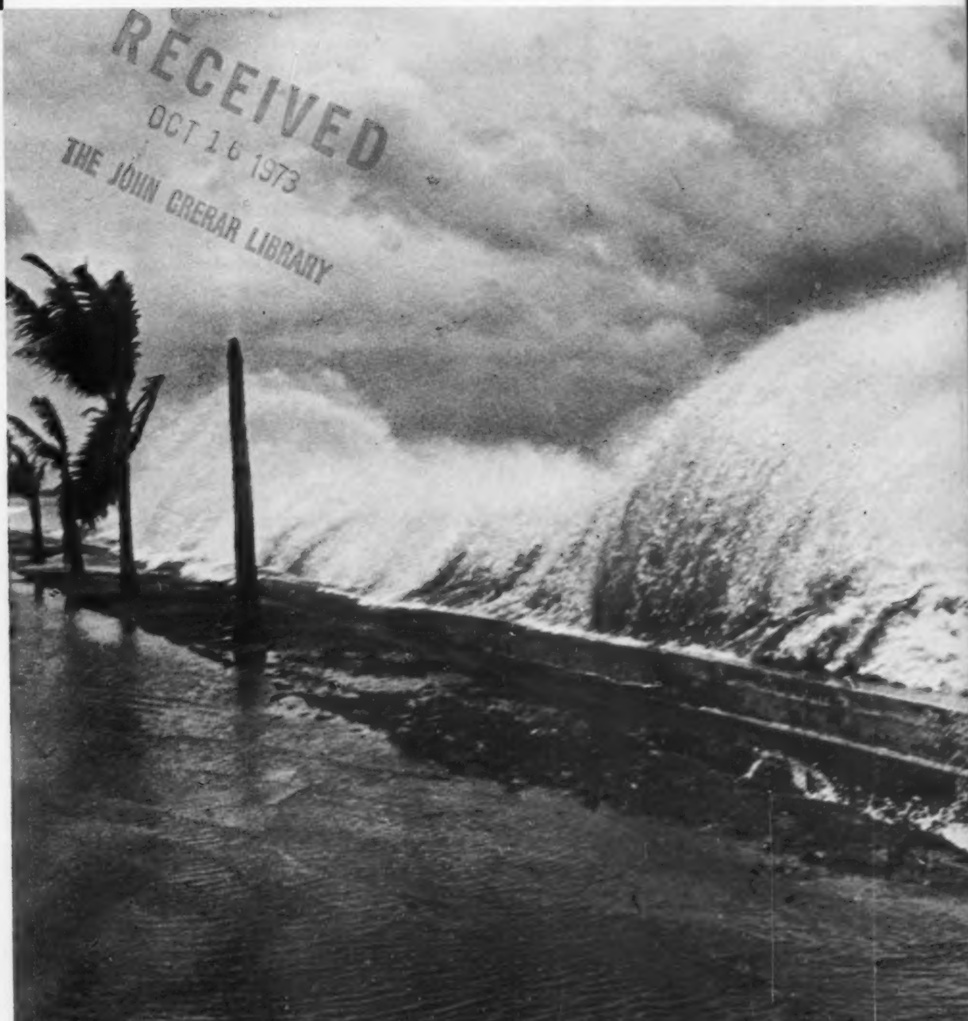
SEPTEMBER 1973



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MARINERS WEATHER LOG

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SEPTEMBER 1973
VOLUME 17, NUMBER 5
WASHINGTON, D.C.

Cover: Twenty-foot waves churned up by high winds lash the seawall along Manila's Roxas Boulevard. These conditions were caused when Susan stalled in the South China Sea and Rita was located in the central Philippine Sea, on July 11, 1972. High seas were built up over the South China Sea by the persistent strong southwesterly flow. On Manila, some sections of the seawall were ripped away by wave action. An article, "Does Manila Bay Provide Shelter Against Typhoons?" appears on page 282. United Press International Photo.

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Master ____________
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PLEASE PASS THIS ISSUE ALONG

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical approved by the Director of the Office of Management and Budget, July 26, 1973.

Copies are available to persons or agencies with a marine interest from the Environmental Data Service, Page Bldg. 2 (D723), 3300 Whitehaven St., N.W., Washington, D.C. 20235.

POSSIBLE USE OF MONOMOLECULAR FILMS IN HURRICANE ABATEMENT

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Mariners have a definite interest in any program involving the abatement of the strength of hurricanes. Evaporation from the sea surface is one of the primary fuels that feed a tropical cyclone.

In the past 5 yr, considerable research has been devoted to the suppression of evaporation from fresh and saltwater-surfaces, utilizing monomolecular films. Some of these films function as a direct barrier to evaporation. Experiments indicate that during test periods of several days, these monofilms can reduce evaporation by 50 to 60 percent. Other films act only to diminish waves and whitecaps, which enhance evaporation, and thus reduce evaporation indirectly.

Simultaneously and independently, several mathematical computer models have been developed that simulate many of the features in a hurricane. Experiments run with these models indicate that hurricane intensity could be substantially reduced if the transfer of heat and/or moisture from the ocean to the air (in the storm circulation) could be reduced. In particular, the intensity would be lessened if evaporation from the ocean could be suppressed.

It seems unlikely that the monomolecular films used in previous tests would survive in the wind and sea conditions that prevail in a hurricane environment. These films are composed of a long hydrocarbon chemical chain that is hydrophobic, and a polar group that is hydrophilic. A hydrophobic substance lacks an affinity for water, i.e., resists wetting, and a hydrophilic substance has a strong affinity for water. The former arranges itself on the surface, and the latter remains in the water. The hydrophilic portion of these films, affecting evaporation directly or indirectly, does not provide enough anchorage to resist wind action. In addition, the close-packed hydrophobic component of the films, acting as a barrier to evaporation, is unable to retain this form under severe wave action. Ideally, a hybrid monofilm that has the characteristics of being tear resistant, spreading easily onto the ocean's surface, and being compatible with the biological systems of the sea (biodegradable) would be the most desirable to use in a hurricane environment, and the most likely to survive.

Illinois Institute of Technology Research Institute (IITRI) has been under contract with the National Oceanic and Atmospheric Administration's (NOAA) National Hurricane Research Laboratory (NHRL) to investigate the feasibility of hurricane abatement employing thin polymer membranes (monofilms). The material found in tank experiments to have the desired characteristics, and most effective as an evaporation suppressant, consisted of linoleic acid, polyvinyl alcohol, and derivatives of polyvinyl acetate. Freshwater lake tests were conducted by IITRI in May 1972, to test the spreadability and wave-damping capacity of this material. These tests indicated that the membrane could be dispensed from small containers to produce an acre of very calm surface (slick), with a clearly visible and stable boundary, in 20 min. These chemicals were determined to be of low toxicity, and the amounts used were small enough not to harm aquatic life. No adverse effects to the induction intake and cooling systems of ships from the ingestion of the chemicals are expected.

The effect of a monomolecular film on the water's surface is most perceptible in its ability to dampen the short waves and prevent the formation of ripples. Recently, some investigators have considered this type of wave suppression as perhaps the major mechanism at work in reducing evaporation, in contrast to the chemical structure (barrier effect) as the major retarding mechanism. In particular, it can be shown that the transfer of moisture from the ocean's surface to the overlying air is directly related to the moisture gradient, wind speed, and the surface roughness. However, in several experiments conducted independently by different investigators, a calculated 10 percent reduction in evaporation was attributed to wave suppression and a 50 percent reduction to the barrier effect, for a total reduction of evaporation of

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60 percent.

The primary goal of the monomolecular film experiments was to examine the feasibility of spreading and maintaining a continuous thin film on the ocean's surface under various wind conditions. Other objectives were to determine the film's rate of spreading, formation and reformation characteristics, endurance on the ocean's surface, and the ability of the film to damp waves. The Naval Research Laboratory (NRL), with similar objectives in mind, participated in the experiment on June 8, 1972, and dispensed a fluid material composed of high-purity commercial oleyl alcohol. The test site area was located 15 mi east of Miami, Fla., in the axis of the Gulf Stream. The test was conducted over a 3-day period, from June 7 to 9, 1972.

The VIRGINIA KEY, a research vessel from the Atlantic Oceanographic and Meteorological Laboratories (AOML), was used as the dispensing platform on the 7th and 8th. The slightly polymerized material was poured from one-gallon bottles, and the oleyl alcohol was streamed from a garden sprayer. Both solutions were disseminated over the side and into the vessel's wake. A spray aircraft dispensed the IITRI material from an altitude of 20 to 60 ft on June 9.

A rectangular spreading pattern was followed by the research vessel and the spraying aircraft on June 7 and 9. Beginning on the western reaches of the mile-square, the north-south legs were chosen to take advantage of the sun angle, for best observational results. An increasing spiral pattern was used for dispensing both materials on June 8, in order to shorten the spreading time required for each material and keep the developing slicks in continuous sight, for comparison purposes.

An instrumented DC-6 aircraft, from NOAA's Research Flight Facility (RFF), and the AOML research vessel were used as monitoring platforms to document the life history of the artificial slicks. Hand-held photography from each platform provided frames with adequate contrast to document the salient features of the slicks. The photographs taken by cameras mounted on the aircraft and operating in time-lapse mode showed poor contrast, due to the presence of haze. Environmental sensors on board the aircraft were operated, but the slick size was too small to provide the long records required for analysis. Thus, the barrier effect was not investigated.

The aircraft monitoring patterns included legs parallel to the slick--looking into and away from the sun--and across various portions of the slicks. They were conducted at altitudes of 100, 500, and 2,000 ft.

Figure 1.--Photograph of the IITRI slick at 1646, June 7, 1972, taken from the aircraft by a hand-held camera.

Figure 2.--Photograph of the NRL slick at 1300, June 8, 1972, taken from the aircraft by a hand-held camera.

The surface vessel moved in and out of the artificial slicks for the purpose of taking photographs and capillary wave-height measurements.

Photographic documentation of the experiments on June 7 and 8 are presented in figures 1, 2, and 3. Weather conditions were similar on both days. Scattered clouds were present, with visibility restricted by haze. The winds diminished to less than 6 kt by midmorning, with the sea surface noticeably rippled.

Figure 1 is a photograph of the IITRI slick at 1646, June 7, approximately 2 hr after spreading ceased. A relatively ordered pattern is discernible with respect to the rectangular spreading pattern used on this day. The rate of application varied considerably with the "pour-from-a-gallon-jug" method, and probably accounted for the patchy appearance seen in many of the lanes.

Figure 2 is a photograph taken at 1300 on June 8, of the NRL slick 1/2 hr after spreading commenced. An increasing spiral spreading pattern was followed by the ship on this day. Similar to the IITRI slick laid the previous day, the NRL slick boundary is easily discernible in contrast to the existing sea state and the sun's glitter pattern. There also appears to be a very striking suppression of waves inside the slick boundary, since the sun's glitter pattern completely disappears here, but is present outside the boundary.

Figures 3a and 3b are photographs taken inside and outside of the IITRI slick at approximately 1615 on June 8, 2 hr after spreading began. It is interesting to note that the polymerized film has apparently suppressed the ripples superimposed on the bow wave of the ship.

A laser-wave profilometer was operated during low-level aircraft passes, to document surface wave-height conditions. On several of these passes, it was apparent that the shorter waves had virtually disappeared. A wave spectrum was computed by standard digital techniques for the high-frequency components of the waves, using the laser wave-height data passed through a high-pass filter, to remove aircraft motion. Figure 4 represents the wave spectrums measured upwind and within the NRL slick, line A and B, respectively. At high frequencies (greater than 0.29 Hz), it is apparent that the wave energy is reduced in the slick. It was found that the energy content within the slick was approximately 54 percent of that outside of the slick. Similar damping was evident during other low-level passes over both slicks.

IITRI chemicals were dispensed from a low-flying aircraft on June 9. This portion of the monofilm experiments was more a test of the dispersing technique

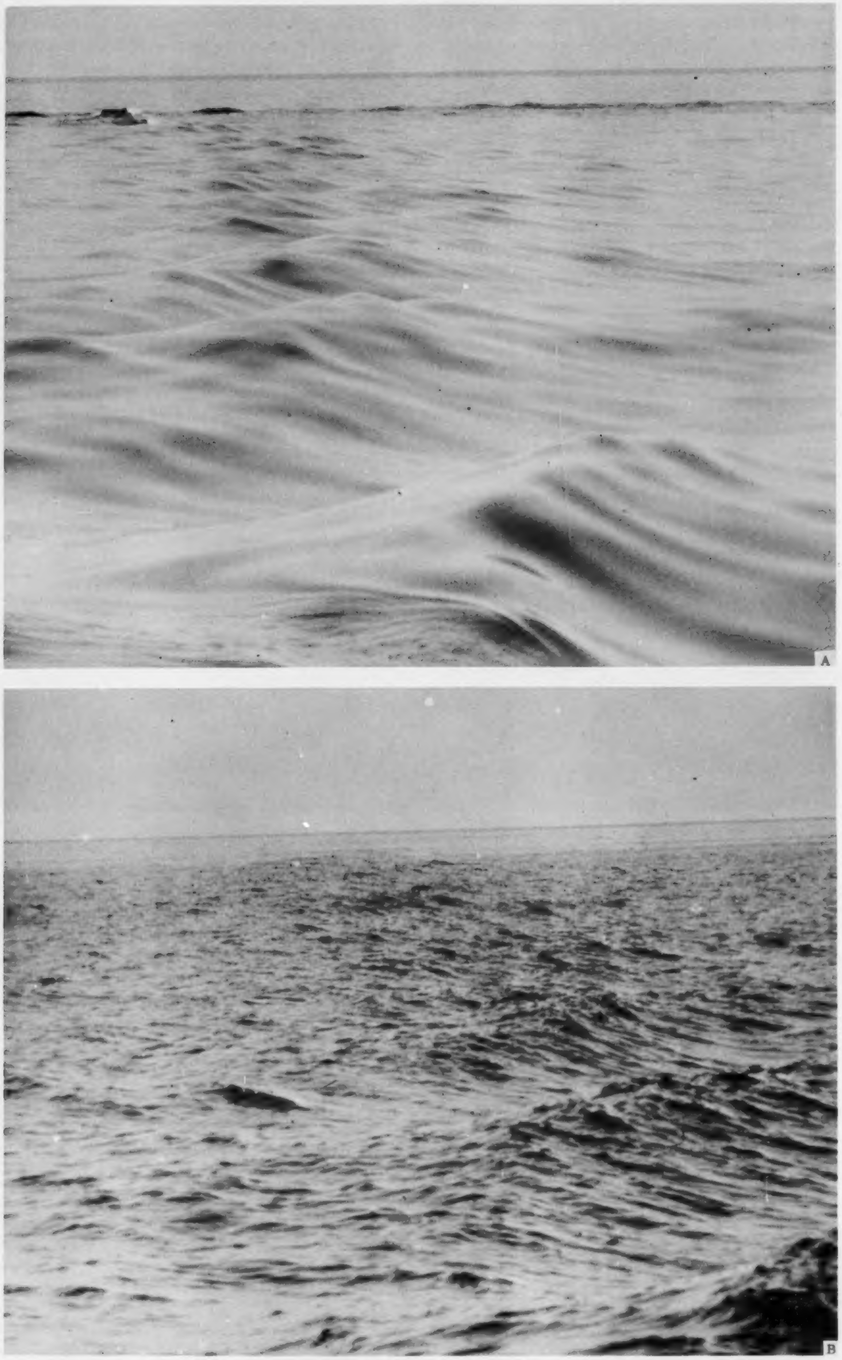

Figure 3.--Photographs taken from the ship at 1615, June 8, 1972, inside (a) and outside (b) of the IITRI slick. Ripples superimposed on the bow wave of the ship have been suppressed by the monofilm.

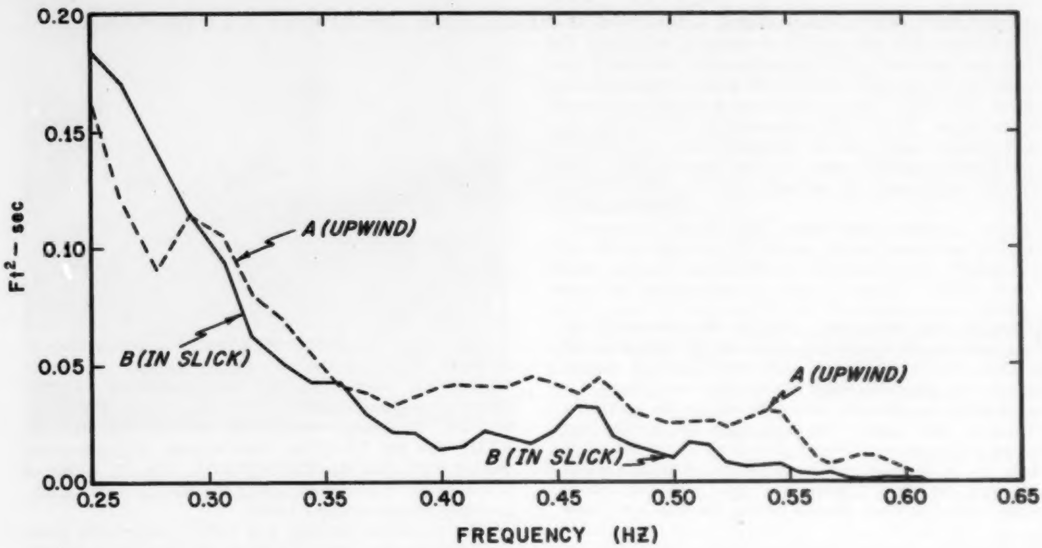

Figure 4.--Spectrum of high-frequency ocean wave energy, computed upwind of the NRL slick, A, and within the same slick, B.

than of the staying power of the film on the open surface of the sea. Slick lines were visible for 5 to 10 min, but were not similar in appearance to the slicks formed on the 2 previous days by the surface vessel.

In conclusion, the slicks were easily seen in contrast with the surrounding area in the research vessel's wake, the existing sea conditions, the sun's glitter pattern, and conformed with the spreading pattern used for that day. Generally, the entire slick took on a patchy appearance 4 hr after spreading ceased. Photographs and laser wave height measurements clearly document the wave damping characteristics of the slicks. It should also be noted that the rate of film spreading was observed to be roughly the same as that estimated for the lake test experiments. Relatively quiescent atmospheric and sea conditions prevailed, unlike those in a hurricane environment.

These experiments have been a necessary step in research on hurricane abatement through sea-air evaporation suppression, since the nature and persistence of artificial slicks has been revealed. Future research should continue to concentrate on these aspects, but now under turbulent sea surface conditions and stronger winds, simultaneously documenting the effectiveness of these films in retarding water vapor transport. In addition, laboratory tests should be continued in an effort to develop a "hybrid" surface membrane with a chemical structure that continues to act as a high energy barrier to evaporation, while, at the same time, makes the film longer-lived for application in hurricane abatement. Increasing the size of the artificial slick to improve detection by airborne and surface environmental sensors is necessary, and could be enhanced by developing improved methods of aircraft dispensing. Simultaneous dissemination of chemicals from both the surface and the air may be desirable, especially in hurricane abatement applications. Evaluation of the potential effectiveness of these membranes in reducing the hurricane's energy may be feasible after the aforementioned improvements are incorporated into a larger scale sea test.

DOES MANILA BAY PROVIDE SHELTER AGAINST TYPHOONS?

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Through the centuries, Manila Bay has had the reputation of sheltering small craft from sea and swell of tropical cyclones. The map of Luzon makes this appear plausible since strong low-level flow will be diverted northward or southward by the mountain ridges of the Bataan Peninsula and the Cavite and Batangas Provinces. Waves that pass Corregidor are likely to be damped to a large extent while spreading out over the Bay. However, two typhoons which passed near or over Manila during the last 3 yr have cast severe doubts on the validity of these statements. The effects of typhoon Patsy, November 1970, (fig. 5) were described in detail in the November 1971 issue of the Mariners Weather Log.

The havoc wrought in Manila Bay by typhoon Ora (Konsing), on the morning of June 25, 1972, was even worse. Ships which were thought to be safely docked at piers found no mercy. Six oceangoing vessels in Manila Bay were swept into the breakwater. Among these were the Singapore freighter SHUN HING (fig. 6), the Philippine ASIA, the marine salvage ship RAMI, the tug URANUA, the College of Engineering vessel PMI, and the ENCANTADA (fig. 7). One of these ships ran aground near the Manila Yacht Club, crushing other smaller boats.

The extensive damage was rather surprising since this typhoon had filled considerably before it passed over Manila, and the measured winds barely reached hurricane strength. Figure 8 shows the track of the typhoon over the Philippines. A carefully detailed

Figure 5.--The PMI ENGINEER, a 500-ton coastal freighter registered in the Philippines, was slammed against the seawall at Manila early on November 19, 1970 by the winds of typhoon Patsy. The 14 crewmen were able to escape by climbing down a rope and jumping onto the land. United Press International Photo.

Figure 6.--The Singapore ship SHUN HING aground after typhoon Ora's departure.

analysis of pressure and wind records of the stations revealed that the pressure in the center rose from 969 mb, near Legazpi at 1700 on the 24th, to 995 mb near Lingayen, Pagasinan at 1000 on the 25th, and that sustained winds above 20 kt never extended more than 100 mi on either side of the track. Note that over open ocean water southwest of the track, winds over 20 kt were virtually absent. In this case, shelter for small craft as well as for large vessels should be located outside Manila Bay on the other side of the mountain ridges.

Figure 9 shows why even weak typhoons which pass over Central Luzon can cause dangerously high winds, waves, and currents in Manila Bay. When the center of the typhoon is close to Manila, inflow from the surface is blocked by the Bataan Peninsula to the west and the Sierra Madre mountains to the northeast. Both mountain ridges have an average height of 2,500 ft above sea level with tops of 5,000 ft or higher. The necessary supply of air is funneled from the Gulf of Lingayen through the Pampanga Valley to reach the Bay at high speeds. Since there are no major obstacles in this valley, very strong northwesterly winds can develop ahead of the typhoon, and last for several hours. In the case of Ora, sustained

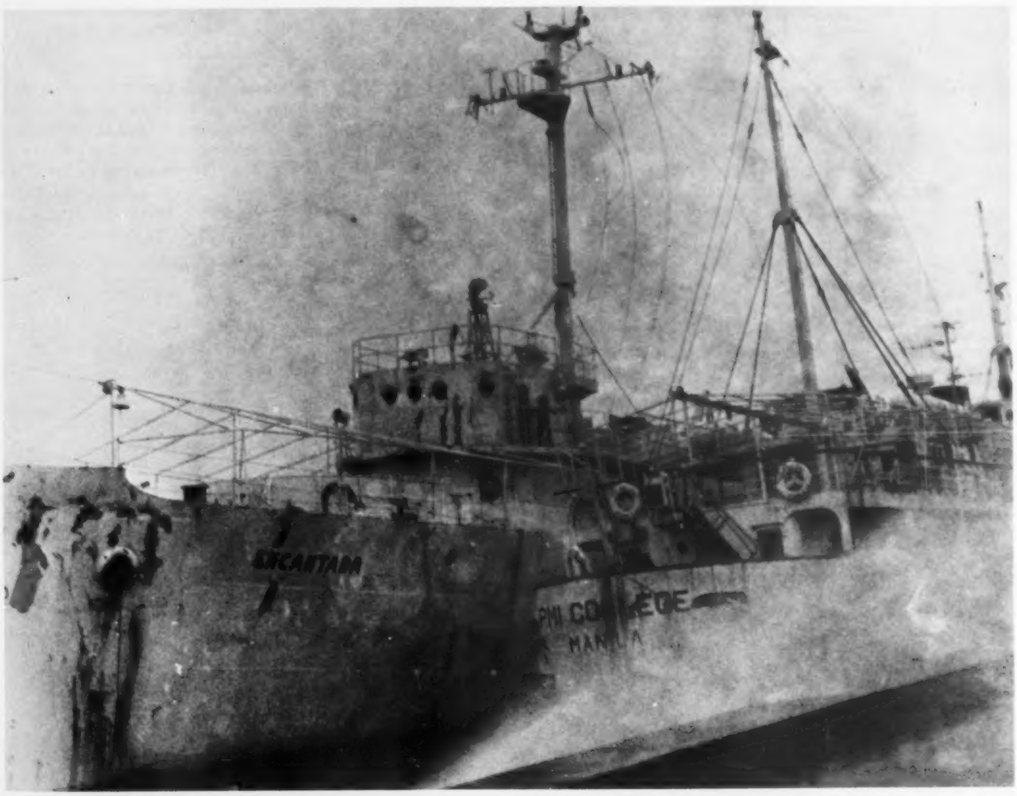

Figure 7.--This photo, taken as Ora whisked through the Philippines, shows two Philippine vessels being beaten by spray after they were driven aground along Manila's Roxas Boulevard.

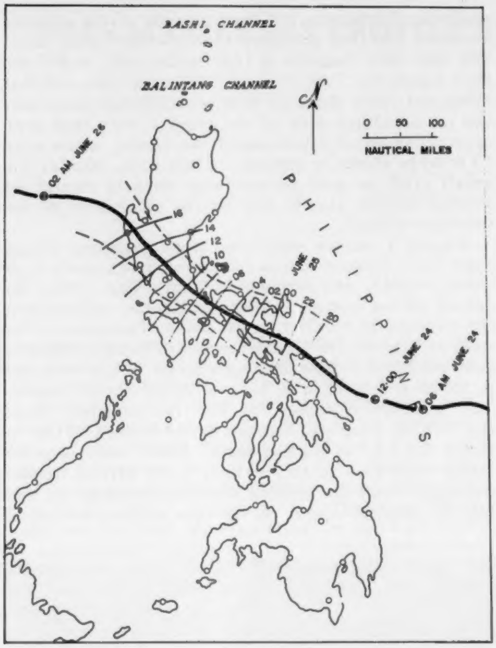

Figure 8.--The track of typhoon Ora over the Philippine Islands with isochrones of lowest pressure occurrence over Luzon. Dashed lines show the outer boundaries of the area with sustained winds of more than 20 kt.

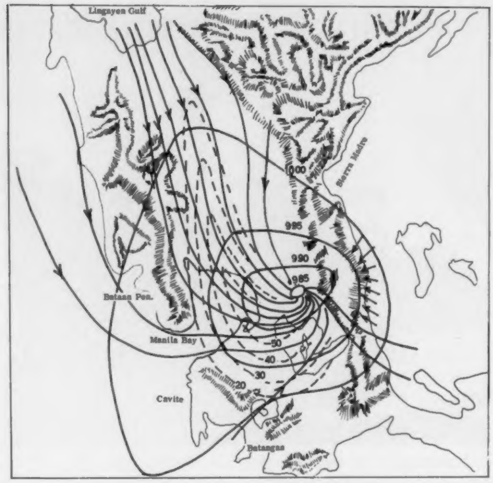

Figure 9.--Isobars (mb), streamlines of surface flow, and isotachs (kt) over Central Luzon at 1300, June 25, 1972 (1100 LST). Windspeeds are in kt.

wind speeds in this flow exceeded 50 kt inland and near the coast. The wind speeds over open water 2 to 3 mi offshore could easily have been over 60 kt, causing ships to drag their anchors and drift toward the seawall of Roxas Boulevard. From the effects of Ora, one might want to consider steaming to the open waters of the South China Sea, when advisories indicate a typhoon center is moving from the southeast toward the Lingayen Gulf or Northern Luzon.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US, THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

THE 1972-73 GREAT LAKES ICE SEASON

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National Weather Service, NOAA
Cleveland, Ohio

Another major advance in the extension of navigation on the Great Lakes was accomplished during the 1972-73 ice season, thanks to a mild winter and close cooperation between private industry and government agencies. An additional week was added to the fall season, which didn't end until February 8, 1973. Navigation resumed less than 2 mo later on March 28. Both dates set new records.

Fall predictions of an early freezeup in some bays and inlets proved valid in December, as outbreaks of cold arctic air marched southward, chilling already colder than normal waters. The first freezeup prediction for the fall was issued on November 16. The Weather Service issued an "Ice Watch" for harbors and channels on the upper lakes on December 4, and 2 days later the USCGC MESQUITE was called out to aid the R. C. NORTON in southern Green Bay. Thirteen other vessel assists were logged during the first half of the month in Green Bay, Saginaw Bay, the lower St. Mary's River, and near Duluth-Superior Harbor. Warmer temperatures and storminess during the remainder of December served to retard further ice growth, and only a dozen vessel assists were required.

The Welland Canal closed on December 15 for planned final construction of a new 8.3 mi leg in the City of Welland. The new channel is straight, has no obstructions, and is both wider and slightly deeper than the old section. The last two passages through the old canal were the Canadian ships TADOUSSAC and PIC RIVER.

Vessel traffic began to dwindle on other Great Lake waters. Coal haulers, which normally continue on the

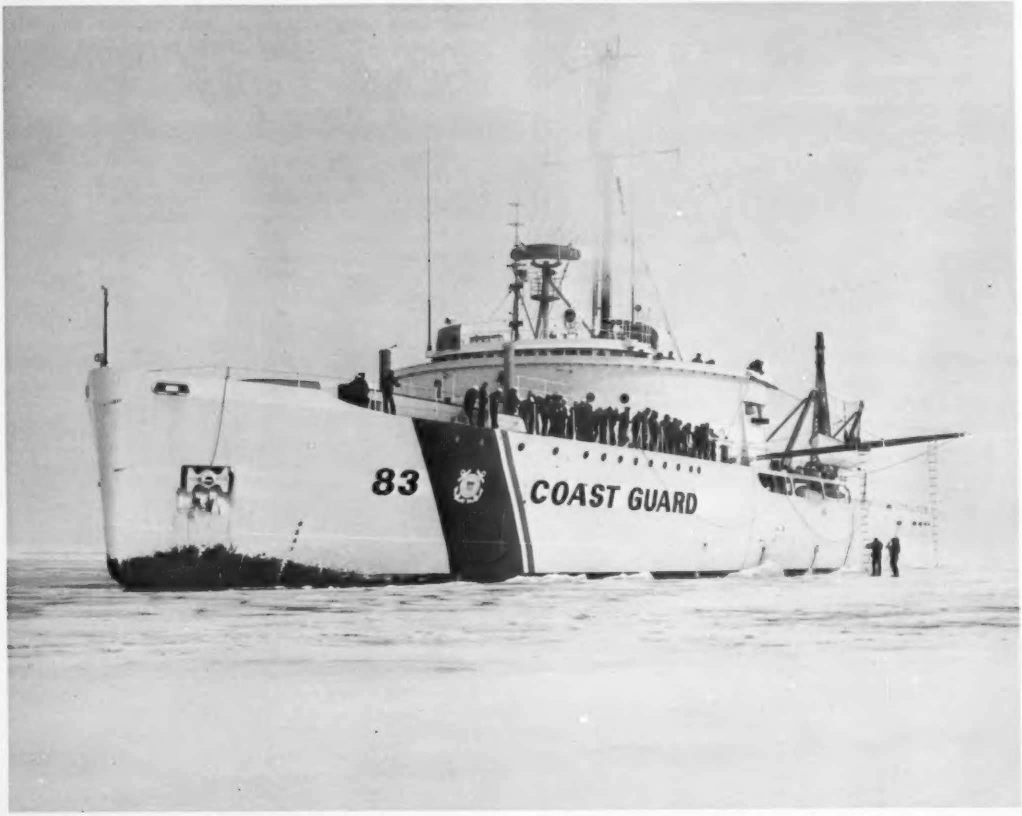

Figure 10.--The icebreakers MACKINAW (above) and SOUTHWIND assisted many vessels caught in the January freeze.

Toledo-Detroit trips into January, ended operations on Christmas Eve. The 1,000-ft STEWARD J. CORT completed its last trip on December 16. Only the new Poe lock remained open at Sault Ste. Marie by December 24.

Routine ice information from the National Weather Service Forecast Office in Detroit and the Coast Guard Ice Navigation Center in Cleveland was started on December 15. The Weather Service expanded its role in the ice program with the assignment of a meteorologist-forecaster to the Ice Navigation Center. The Detroit Forecast Office doubled its output with the issuance of a daily "Ice Forecast" and "Ice Outlook."

Rapid ice formation occurred during the first half of January, as temperatures remained consistently below normal for the period. Ice up to a foot thick covered Green Bay, Saginaw Bay, and southwestern Lake Superior around the Apostle Islands. Significant ice ranging from 2 to 14 in was reported on the St. Mary's River. Almost 100 vessels were aided by Coast Guard tugs and the two Great Lakes icebreakers MACKINAW (fig. 10) and SOUTHWIND.

The harsh winter cold eased considerably in middle and late January, and the ice cover stabilized or diminished in northern waters, while disappearing almost completely from southern areas. In spite of the improved conditions, shipping continued to dwindle during the period. Shipping operations terminated in Green Bay and Saginaw Bay. The hardy tanker fleet continued its normal winter operations. Of the remaining fleet, only the U.S. Steel ore carriers continued operating by the end of the month.

Seven U.S. Steel ships, including the 22,000-ton flagship ROGER BLOUGH, fought on into early February to bring the much needed iron ore from the frozen lakehead region to the hungry blast furnaces at the end of Lake Michigan and around Lake Erie. The steamers A. H. FERBERT and C. J. CALLAWAY cleared the locks at Sault Ste. Marie on February 8, 1973 (fig. 11), adding another week to the previous record late date, set in 1972.

Persistent cold temperatures during the remainder of February increased the ice cover significantly. As usual, Lakes Erie and St. Clair responded quickly to the frigid weather and froze over nearly completely, while the larger deep-water areas of Lake Huron, Lake Superior, and most of Lake Michigan and Lake Ontario remained open. The maximum ice cover for the season was observed during the last few days of the month (fig. 12).

The late fall and winter navigation season challenged the shipping industry and U.S. Coast Guard icebreaking fleet alike, but the spring opening proved to be one of the easiest in years. March was unseasonably warm. This, combined with increased solar radiation, resulted in a virtual elimination of the ice cover on the lower lakes early in the month, and over the remainder of the lakes by month's end--much sooner than normal. The locks at Sault Ste. Marie, the Welland Canal, and the St. Lawrence Seaway all opened for business on

Figure 11.--The C. J. CALLAWAY and the A. H. FERBERT established the record-breaking date of February 8, 1973 for passage through the Soo Locks. Photo courtesy of Albert G. Ballert.

Table 1. --Opening of Navigation

Location	Forecasted 1973 Opening-Icebreakers	Forecasted 1973 Opening-Natural	Actual 1973 Opening	Average Opening (Historical)	Earliest Recorded Opening
Duluth	April 2	April 11	*March 29	April 10	March 1, 1911
Whitefish Bay	March 30	April 10	**March 28		
St. Mary's River	March 29	April 9	**March 28	April 14	March 22, 1942
Straits of Mackinac	March 24	April 7	*March 30	April 4	March 16, 1964
Green Bay	March 29	April 8	**March 31 **(March 23 at Gladstone on Little Bay de Noc)	April 12	March 24, 1946
Southern Lake Huron	March 18	March 26	*March 14		
Saginaw Bay	March 26	April 1	(Ice-free on March 15)		
Detroit	March 18	March 26	*March 14	March 23	March 1, 1937
Western Lake Erie (Cleveland)	March 20	March 27	*March 20	March 24	March 1, 1937
Buffalo	April 4	April 14	*March 20	April 11	March 2, 1963

*Without direct icebreaker assistance
**Not known whether icebreaker assistance rendered

Table 2. --Great Lakes Temperature (°F) Departures from Normal for 1972-73 Season.

Month	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
November	-1.0	-0.1	-1.1	-0.0	-0.1
December	-4.9	-3.8	-0.2	+2.5	+4.3
January	+3.0	+3.5	+2.9	+2.5	+3.4
February	+0.9	+2.0	-1.6	-1.6	-2.7
March	+10.1	+9.5	+9.2	+9.8	+10.2
November-March	+1.6	+2.2	+1.8	+2.2	+2.4

March 28, 1973, the earliest ever, and the first time in 20 yr before April 1. The "Outlook for the Opening of Navigation" was issued by the National Weather Service on March 5, 1973 (table 1). The actual opening dates listed are the dates of arrival or departure of the first vessel.

The normally ice-clogged extreme eastern end of Lake Erie was ice-free during most of March 1973. Plans for the annual "Operation Open Buffalo" were canceled by the Ninth Coast Guard. Several assists to ships were still required in the Straits of Mackinac, Georgian Bay, and Duluth-Superior. The steamer J. G. MUNSON was the first vessel to clear the Soo locks. She reached Duluth on March 29, with some assistance from the MACKINAW in Whitefish Bay on the previous day. Persistent northeast winds across Lake Superior impeded the breakup of ice around Duluth. The USCGC WOODRUSH aided the AUGUST ZIESING in Duluth on Friday, April 13, 1973, the last assist of the season. The ice continued to melt during the weekend and was gone by the 16th.

The unseasonably mild weather during March brought the average temperature for the November to March period about 2° above normal for all five Great Lakes (table 2). The early decay of ice cover is also reflected in the early date of maximum accumulation of freezing degree days. A freezing degree day is defined as the departure of the mean daily air temperature below 32°F of 1° (table 3).

The Great Lakes Region is known for its extreme and frequently changeable weather, but the ice season of 1972-73 will stand for some time to come as one of the most unique. More commercial shipping companies and more ships than ever before participated in the extended winter operation season. Icebreaking assists, during freezeups early in the season, went up significantly, compared to the same period last year. However, the mild opening season produced few problems, and total assists for the season decreased from 466, during 1971-72, to 263, during 1972-73. Only time will tell what the next season will bring--in three short months--but industry and government alike stand ready to meet the challenge.

Figure 12.--The maximum Great Lakes ice cover, as observed on February 28, 1973 by the NOAA-2 Very High Resolution Radiometer (VHRR). Lake Erie and Lake St. Clair are nearly frozen over. Widespread ice coverage is observed along southern Lake Superior, the St. Mary's River, the Straits of Mackinac, Green Bay, Saginaw Bay, southern Lake Huron, Georgian Bay, and the North Channel (insert--February 27, 1973). Hudson Bay is completely covered with ice. The St. Lawrence River and the Gulf of St. Lawrence are almost completely frozen.

ACKNOWLEDGMENTS

Tables 1, 2, and 3 were compiled by Bernard DeWitt & Associates. Some background and statistical data is taken from their 1972-73 "Final Report on Ice and Weather Forecasting," submitted to the National Weather Service Headquarters, June 1973. Icebreaking information and data was furnished by Lt. Tom Brennan, Chief, Icebreaking Section of the Ninth Coast Guard District, Cleveland, Ohio

Table 3. --Maximum Accumulated Freezing Degree Days (FDD).

Station	Maximum Accumulated FDD--1972-73	Date	Normal Maximum Accumulated FDD	Date	1972-73 Season Versus Normal
Duluth	2131	March 21-22	2573	April 22	-442 (warmer)
Marquette	1061	Feb. 27-28	1415	April 15	-354
Sault Ste. Marie	1326	March 2	1787	April 16	-461
Green Bay	1054	Feb. 28	1573	April 8	-519
Milwaukee	767	Feb. 27-28	1250	April 7	-483
Muskegon	466	Feb. 28	833	April 7	-367
Alpena	984	Feb. 27-28	1416	April 18	-432
Detroit	347	Feb. 28	750	April 1	-403
Toledo	347	Feb. 28	822	April 1	-475
Buffalo	440	Feb. 28	954	April 12	-514
Rochester	367	Feb. 28	898	April 8	-531

Daily freezing degree days = (32) minus (Daily mean temperature)

Hints to the Observer

DIURNAL PRESSURE VARIATION AND TROPICAL CYCLONE DEVELOPMENT

Similar to ocean tides, atmospheric pressure rises and falls twice a day. This pressure "tide" is called diurnal pressure variation. During each 24-hr period two highs occur, one at approximately 1000 and the other at 2200, local time. The two lows occur at approximately 0400 and 1600, local time. The range of the diurnal pressure change is greatest in tropical areas and becomes smaller toward the middle and higher latitudes. In the middle and higher latitudes, the movement of storm centers during much of the year causes such large changes in pressure that the normal diurnal variation is masked. In tropical waters, however, the barograph trace will usually show the familiar sine curve, with two crests and two troughs during a 24-hr period, as illustrated in the barogram (fig. 13) from the DOLLY TURMAN on August 19-20, 1966.

In the tropics, changes from the normal diurnal pressure pattern may indicate formation of a tropical cyclone. The usual signs are that the minimum trough of the barograph trace or other pressure record is much deeper, or that the maximum fails to develop. By use of the barograph and reference to one of the marine atlases it is possible to tell whether or not the change from the normal diurnal value is significant. Under normal conditions the diurnal variation should oscillate about the mean pressure value. Whenever the diurnal value drops 3 to 5 mb below

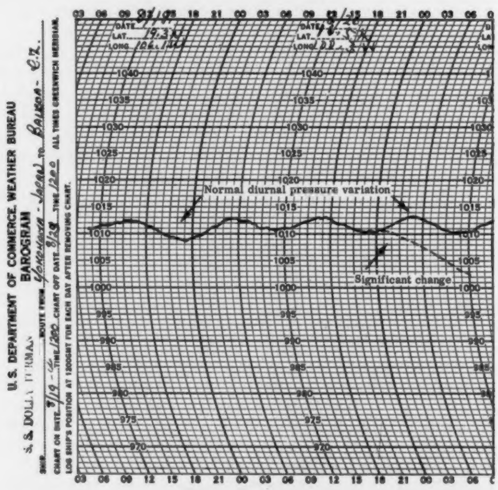

Figure 13.--The DOLLY TURMAN's barogram showing normal diurnal pressure variation in the tropics. Significant change from this regular rhythm may herald an approaching tropical cyclone.

the mean pressure during the hurricane season, a tropical cyclone is probably developing in the area. Figure 13 shows the normal range of diurnal pressure variation for a latitude of 13°N to 19°N. The diurnal variation shown is considered normal for an area with a mean pressure value of 1012 mb.

The dashed line in figure 13 plotted on the second day's record shows a change in pressure which is typical during tropical cyclone development. Other significant weather parameters should be observed, depending on the location of the ship, such as a change in the wind direction to a westerly component, or higher than the normal wind speeds; an increase in shower activity which tends to persist; and an increased swell pattern or a swell pattern moving from an unusual direction for the particular waters.

Tips to the Radio Officer

Warren D. Hight
National Weather Service, NOAA
Silver Spring, Md.

NEW EDITION OF PUBLICATION U.S. AND FOREIGN COASTAL RADIO STATIONS ACCEPTING SHIPS' WEATHER OBSERVATION MESSAGES

The 1973 edition of the booklet U.S. and Foreign Coastal Radio Stations Accepting Ships' Weather Observation Messages has been mailed directly to the radio officers of all weather-reporting ships in the U.S. program. If, for some reason your copy isn't delivered, please notify one of the National Weather Service Port Meteorological Officers, or write to:

National Weather Service
Marine Weather Services (W115x1)
8060 13th Street
Silver Spring, Md. 20910

REPORT ON STATUS OF NEW PUBLICATION WORLDWIDE MARINE WEATHER BROADCASTS

It is now estimated that the earliest possible date that delivery of Worldwide Marine Weather Broadcasts can be expected is some time in November.

WEATHER BROADCAST OVER TIME AND FREQUENCY STATION WWVH, KAUAI, HAWAII, IS EXPANDED

Recently, a third 45-sec voice weather broadcast was added to the program of Bureau of Standards Radio Station WWVH. These weather segments of the WWVH broadcast commence at 47, 49, and 51 min past each hr. By listening to all three segments, a mariner will know the positions, movement, and areas of maximum wind speed of all storms in the North Pacific, and in the South Pacific from the equator to 25°S, between 110°W and 160°E.

U.S. MARINE WEATHER FORECAST DISSEMINATION STUDY UNDERWAY

A review of U.S. marine weather forecast dissemination procedures and contents is being undertaken by the National Weather Service (NWS). The review includes, but is not limited to, area coverage and reception, format and modes of transmissions, broadcast contents and schedules, and flow of forecast information from NWS forecast offices to various broadcast stations. The study is expected to lead to an integrated plan for marine services for all parts of the oceans for which the U.S. has warning and forecast responsibility. Also, recommendations as appropriate will be made concerning other areas in the world's ocean.

CORRESPONDENCE FROM RADIO OFFICERS

We wish to thank William L. Barnard and Max Grossman, Radio Officers on the BALTIMORE TRADER and HESS BUNKER, respectively, for reporting on deficiencies noted in some of the marine weather broadcasts. Comments such as theirs are necessary to ensure a responsive service program. As stated some time ago in this column, we want to hear from anyone who has a complaint or useful information concerning weather broadcasts listed in Weather Service for Merchant Shipping. Letters should always contain full details, such as station, date, time of broadcast, and nature of the problem or suggestions for improvement. Of course, we are always glad to hear from those who are pleased with a particular broadcast; we will share any such comments with the radio stations concerned.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

Hurricane Alley

Richard M. DeAngelis
Environmental Data Service, NOAA
Washington, D. C.

Autumn brings subtle changes to the Southern Hemisphere tropics. During April in the South Indian and western South Pacific Oceans, infrequent gales become more infrequent, southeast trades become more persistent, and tropical cyclone activity decreases. The tracks for the March 1973 tropical cyclones are shown in figure 14, and for April 1973, in figure 15.

SOUTH INDIAN OCEAN (west of 100°E)

March usually brings two tropical storms and one hurricane. In April an average of one tropical cyclone develops, with better than even chances of remaining below hurricane strength. This March (1973) brought one hurricane and one tropical storm. In April (1973) two hurricanes came to life.

The March hurricane was discovered northeast of Diego Garcia on the 2d. As many storms do, it swung southwestward toward the Malagasy Republic, but recurved before reaching the island. Early on the 7th, the hurricane whipped St. Brandon with 40-kt winds, as she passed 120 mi to the north. Twenty-four hours later, the island of Serge Frolow reported 35-kt winds. On the outskirts of the circulation, some 400 mi to the east-southeast, the SCHIE LLOYD ran into 30-kt winds on the 8th. The large storm (fig. 16) maintained hurricane intensity until the 12th. During this period several ships, including the AL KUWAIT and the E. R. ANTVERPIA, battled 30- to 35-kt winds more than 100 mi from the storm's center.

Short-lived tropical storm Paula became the month's second storm on the 28th, some 300 mi northwest of the Cocos Islands. The following day she passed within 60 mi of the islands, but then turned southwestward. Paula never really developed and dropped to depression strength by the 31st.

There was a lull in activity for the first few weeks of April. It was shattered on the 18th when Roma was sighted, some 700 mi southeast of Diego Garcia.

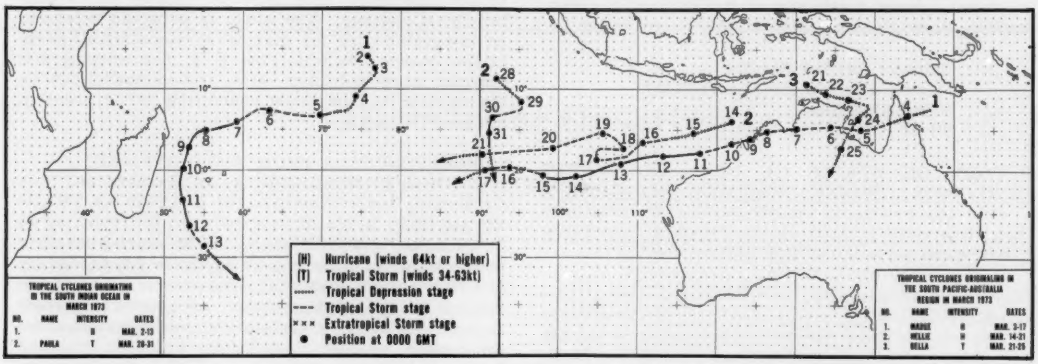

Figure 14.--Southern Hemisphere tropical cyclones, March 1973. Solid line indicates hurricane portion of track.

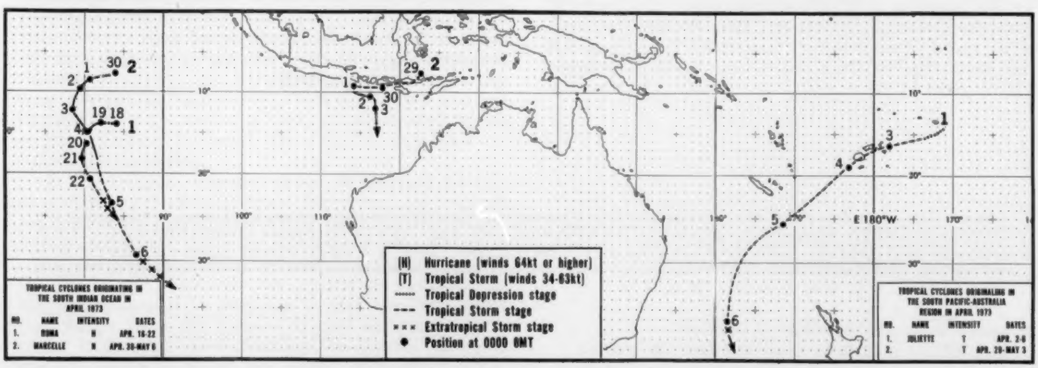

Figure 15.--Southern Hemisphere tropical cyclones, April 1973. Solid line indicates hurricane portion of track.

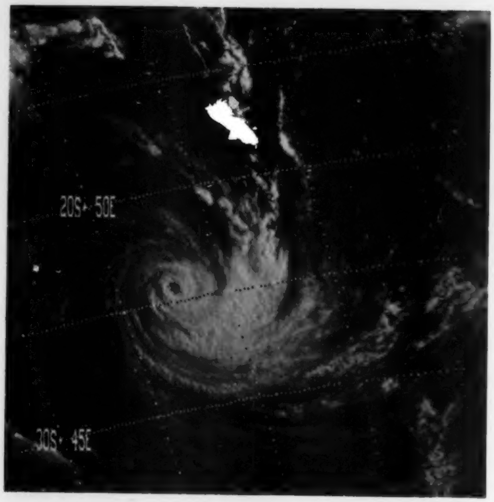

Figure 16.--The unnamed March hurricane presents a near perfect eye as she churns the waters of the South Indian Ocean at 0501 March 11, 1973.

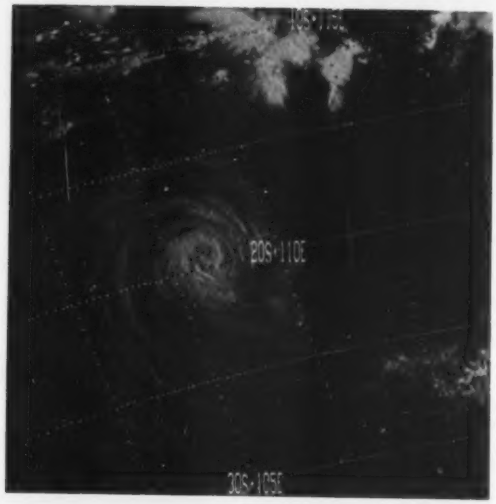

Figure 18.--Spinning off the west coast of Australia, Madge displays the circulation that created her 100-kt winds at 0105 March13, 1973.

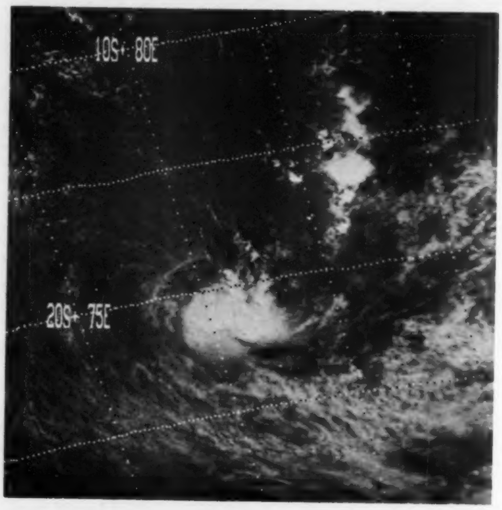

Figure 17.--Roma was never a well-developed hurricane. Here she is seen dissipating near 21°S, 82°E, at 0319 April 22.

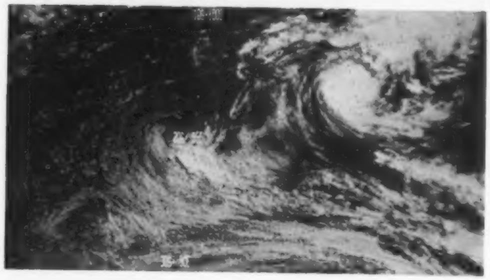

Figure 19.--Twin storms Madge (left) and Nellie pass in review in the eastern half of the South Indian Ocean on March 16, 1973, at 0155.

Quickly Roma turned southward. She was doomed to a life at sea, but she stayed away from shipping traffic. Roma was a minimal hurricane from the 18th to the 21st. By the 22d, she was becoming a weak extratropical storm (fig. 17).

A week later, Marcelle began in the same waters. She was spotted on the last day of the month. On May 3, Diego Garcia, some 300 mi northwest of the storm's center, observed 55-kt southwesterlies. Marcelle had reached hurricane strength by this time. Winds close to her center were 70 kt. However, she moved rapidly south-southeastward and, by the 6th, became extratropical, south of the 30th parallel.

SOUTH PACIFIC and AUSTRALIA

March usually brings two to three tropical storms and one hurricane. In April, one to two tropical storms develop on the average. There is a chance that one will reach hurricane intensity. This March saw two hurricanes and one tropical storm, while April brought two typical tropical storms.

Madge germinated on the 4th of March in the Coral Sea. Her growth was inhibited by a trek across northern Australia. However, once into the nurturing waters of the Timor Sea, Madge quickly blossomed into a full-fledged hurricane. By the 13th (fig. 18), 100-kt winds roared around her center and gales extended out close to 300 mi. This potent storm remained a hurricane until the 15th. At this same time, Nellie was developing back in the Timor Sea. For a brief time on the 16th (fig. 19), these two tropical storms covered more than one-half of the South Indian Ocean.

However, while Nellie blossomed, Madge faded. Nellie had a brief fling as a hurricane late on the 16th. The ZENKOREN MARU No. 2 ran into 30-kt winds of the weakening tropical storm on the 17th, some 130 mi from Nellie's center. Nellie hung on until the 21st, when she weakened to depression strength, close to where Madge had weakened 4 days earlier. But while Nellie was dying, Bella was coming to life back in that tropical nursery known as the Timor Sea. Bella, however, moved to a different drummer. She took off eastward across the Arafura Sea, into the Gulf of Carpentaria. Bella reached tropical storm strength on the 24th. Then she crossed the Northern Territory coast near Borroloola. The storm slowly dissipated over the continent.

April activity was widely scattered. Juliette formed near Samoa on the 2d. The second tropical storm developed in the Flores Sea of the Indonesian region on the 29th. Tropical storm Juliette moved southeastward through the Fiji Islands on the 3d. Winds near her center reached 60 kt that day and on the 4th. By the 5th, Juliette began to weaken, as she passed southeast of New Caledonia. She became extratropical on the 6th, south of the 35th parallel.

The tropical storm that developed at the end of April moved along the coast of Java and the islands to the west. On May 1, she suddenly turned southward. Ironically, the storm died in the Timor Sea, where several storms had previously developed.

On the Editor's Desk

WIND CHILL--EQUIVALENT TEMPERATURES

All mariners are familiar with the difference in coldness one feels at a given temperature, depending on whether he is in the open wind on deck or sheltered.

The temperature of the air is not always a reliable indicator of how hot or cold a person will feel when outdoors. Other elements such as wind speed, relative humidity, and sunshine exert an influence. In addition, the type of clothing worn, as well as the state of health and metabolism of an individual, will have an influence. Generally, coldness is related to the loss of heat from exposed flesh; it can be assumed that coldness is proportional to the measured rate of heat loss from an object.

Heat loss occurs by means of radiation, conduction, and convection. Radiation and conduction are more constant than convection, therefore a formula and graph can be determined on wind and temperature alone. The accompanying table is a good approximation of the chill caused by convection--wind.

Conditions such as physical exertion, being in bright sunshine, heavy breathing of cold air, and health are not taken into consideration.

NEW ERA IN NAUTICAL CHART PRODUCTION INAUGURATED WITH PUBLICATION OF FIRST AUTOMATED CHART

Inaugurating a new era in nautical chart production, the National Oceanic and Atmospheric Administration announced the publication of the first chart produced largely by automation.

The prototype chart is the result of a 10-yr, $25 million program which is expected to become fully operational by 1980. By then, the agency hopes to largely eliminate the slow and tedious manual preparations involved in the production of the approximately 2.5 million charts it prints each year for coastal areas, estuaries, harbors, the Great Lakes, and various other lakes and rivers.

Table 4.--Wind chill equivalent temperature. Example shows 20°F temperature with a 10 mi/h wind has an equivalent temperature of 3°F.

DRY BULB TEMPERATURE (°F)

WIND VELOCITY (MPH)	45	40	35	30	25	20	15	10	5	0	–5	–10	–15	–20	–25	–30	–35	–40	–45	
4	45	40	35	30	25	20	15	10	5	0	–5	–10	–15	–20	–25	–30	–35	–40	–45	4
5	43	37	32	27	22	16	11	6	0	–5	–10	–15	–21	–26	–31	–36	–42	–47	–52	5
10	34	28	22	16	10	3	–3	–9	–15	–22	–27	–34	–40	–46	–52	–58	–64	–71	–77	10
15	29	23	16	9	2	–5	–11	–18	–25	–31	–38	–45	–51	–58	–65	–72	–78	–85	–92	15
20	26	19	12	4	–3	–10	–17	–24	–31	–39	–46	–53	–60	–67	–74	–81	–88	–95	–103	20
25	23	16	8	1	–7	–15	–22	–29	–36	–44	–51	–59	–66	–74	–81	–88	–96	–103	–110	25
30	21	13	6	–2	–10	–18	–25	–33	–41	–49	–56	–64	–71	–79	–86	–93	–101	–109	–116	30
35	20	12	4	–4	–12	–20	–27	–35	–43	–52	–58	–67	–74	–82	–89	–97	–105	–113	–120	35
40	19	11	3	–5	–13	–21	–29	–37	–45	–53	–60	–69	–76	–84	–92	–100	–107	–115	–123	40
45	18	10	2	–6	–14	–22	–30	–38	–46	–54	–62	–70	–78	–85	–93	–102	–109	–117	–125	45

NOAA's National Ocean Survey is the federal government's major producer of domestic nautical charts and supplies most of the charts produced for the nation's 46 million recreational boaters, the shipping industry, the armed forces, and the Coast Guard.

This first computer-supported chart (C&GS 414) covers a small portion of Mississippi Sound in the Gulf of Mexico, from Horn Island Pass into the harbor of Pascagoula, Miss. The initial printing of approximately 2,500 copies will record the publication of the first automated chart to be published by the National Ocean Survey with the words: "This publication utilized computer assistance and machine engraving techniques." The chart is available for $1.75 from the National Ocean Survey, Distribution Division (C44), Riverdale, Md., 20840, or from any of the National Ocean Survey's 1038 nautical chart sales agents.

The new process being perfected eliminates about 90 percent of the manual labor required in the engraving of data on nautical charts. Under this process, the source data are fed into computers, processed, recalled as needed, engraved on special coated plastic sheets (chart negatives) by automated plotters, and then printed.

Once the program is fully operational, most data now appearing on nautical charts will be programmed for the computer. These data can then be recalled, not only for charts, but for other purposes as well. The computer could provide, for example, a list of wrecks along the coast, including their position, the depth of the water above them, and possibly some information on the wrecks themselves. Fishermen may also in the future be able to call upon the National Ocean Survey for a computer-produced list of fish havens, shoal areas, and other sites considered favorable for fishing. A request for a list of navigational aids in a specific area could be complied with quickly under the automated process, instead of having it laboriously compiled by hand. These are a few examples of what can be accomplished once the automated chart production program is fully operational. It will be possible to recall from the digital data files almost everything in the way of nautical data that now appears on the charts.

Automation of chart production will also speed up publication of new and revised charts. It now takes about 12 to 18 mo to produce a new chart, from the time the data is received. Under an automated program, it should be possible to produce charts in 4 to 6 mo. For revised charts, those updated to incorporate new data, production time should be reduced to 3 mo or less, instead of the 5 mo it now takes.

The massive task of converting the present nautical chart file of hydrographic surveys from graphic format to machine-processable digital format is being performed for the National Ocean Survey by the National Climatic Center of NOAA's Environmental Data Service.

FEDERAL AGENCIES ANNOUNCE PLANS FOR PARTICIPATION IN WORLD WEATHER PROGRAM

Substantial progress is being achieved through the World Weather Program, President Richard Nixon says, in his message to Congress transmitting the plan for U.S. participation in the international effort during 1974.

Operational geostationary satellites will soon provide a nearly continuous view of storms over a large part of the earth's surface, strengthening our ability to predict and warn of potential natural disasters. Polar-orbiting satellites making vertical measurements of the global atmosphere are already an important aid to weather forecasting. Significant advances in computer science are now helping to extend the range, scope, and accuracy of weather predictions, and to assess the impact of pollution on climate and weather.

Planning is nearly complete for a large-scale international experiment to be conducted in 1974 in the tropical Atlantic. This experiment will seek a better understanding of the effects of the tropics on global weather patterns. As a result, new insight into the life cycle of hurricanes that affect the coastal areas of the United States is expected.

The World Weather Program is an international effort, coordinated by the World Meteorological Organization, to extend the time, range, and scope of weather predictions, to develop means for assessing the consequences to global environmental quality of man's pollution of the atmosphere, to determine the feasibility of large-scale weather modification, and to establish new bonds of international cooperation.

Nations are planning to combine their resources in 1977 to observe the entire earth's atmosphere for the first time as a single physical system.

The World Weather Program has two major components--the World Weather Watch and the Global Atmospheric Research Program--supported by a Systems Design and Technological Development effort.

The major U. S. contributions to the World Weather Watch during the coming year include expanding the capability of the current operational satellite system, developing new techniques for processing satellite data, establishing an atmospheric baseline monitoring station, and providing assistance to the meteorological services of developing nations.

NASA will launch two Synchronous Meteorological Satellites, prototypes for NOAA's Geostationary Operational Environmental Satellite system. These spacecraft will permit virtually continuous observation of the environment over the United States and large areas of the Atlantic and Pacific Oceans, and also will collect and relay data from remote platforms such as buoys, ships, automatic stations, aircraft, and balloons.

NOAA plans to develop, test, and operate weather forecast models of increased detail and accuracy, using an improved computer and global data available from the new satellite observing systems.

The GARP Atlantic Tropical Experiment--called GATE--will be conducted from June 15 through September 1974, to learn more about the meteorology of the tropical atmosphere and its effects on the circulation of the earth's atmosphere as a whole. Ships, aircraft, and satellites provided by a number of countries, including the United States, will take part. In preparation for the experiment, the U.S.S.R., Mexico, and the United States held an international sea trial during August 1973, to bring together data aquisition systems for intercomparison and intercalibration, test data handling plans, provide operational training, and obtain preliminary data from the experimental area.

In preparation for the first GARP Global Experiment in 1977, NASA will design a Data Systems Test to be carried out simultaneously with the GATE project.

The test, intended to determine the scope and adequacy of observing and data handling systems planned for the global experiment, will make use of the conventional global observing system, and will include both operational and research satellites.

The World Weather Program Plan for Fiscal Year 1974 includes a section describing plans for the first GARP Global Experiment. It is designed to obtain a complete set of global observations covering a period of about a year--including 2-mo-long intensive observing periods. The collected data will be used in research designed to gain increased understanding of atmospheric motion and develop more realistic models for long-range forecasting and atmospheric research; assess the ultimate limit of predictability of atmosphere systems; develop methods to utilize more fully information gathered by a sophisticated global observing system; and design a composite observing system for the operational World Weather Watch system.

Two polar-orbiting satellites and five earth-synchronous spacecraft are expected to be operating during the global experiment. Of the earth-synchronous spacecraft, two will be operated by the United States; one, over the Indian Ocean, by the Soviet Union; one by Japan, stationed over the western Pacific; and one by the European Space Research Organization, planned for orbit over Africa and the eastern Atlantic. Polar-orbiting satellites will be provided by the United States and the U. S. S. R.

Earth-based observations from World Weather Watch networks and some special observing systems--such as ocean buoys, constant-level balloons, and ships--will also be required for the experiment. NASA's Nimbus G satellite, which will make oceanographic and environmental pollution measurements, is expected to be launched during 1977.

Observations collected during the global experiment will be processed at the World Meteorological Centers located in Melbourne, Australia; Moscow, U. S. S. R.; and Washington, D. C.

SCIENTISTS PROPOSE STUDIES OF "UNDERWATER WINDMILLS" FOR POWER GENERATION

Three scientists suggest that man may one day use the energy of the northward-flowing Gulf Stream to spin electric generators in systems the scientists liken to underwater windmills. They propose that specialists in marine engineering, power engineering, and related fields get together to consider the economic and engineering feasibility of harnessing the Gulf Stream.

The Florida Current, a major component of the Gulf Stream, carries more than 50 times the total flow of all the freshwater rivers of the world right past Miami's front door. The average velocity in the zone between Florida and Bimini is 2 mi/hr, but near the surface, the speed sometimes exceeds 5.5 mi/hr.

Calculations show that water flowing in the upper layers of the Florida Current could produce about 0.8 kilowatt of power per square meter of cross section of the stream if this energy could be extracted. This is over ten times the average energy per square meter of solar cells available from sunlight in the south Florida area. The total energy of motion of the current could thus produce about 25,000 megawatts--the output of 25 of the largest power plants built by man--if all the energy could be harnessed.

However, the scientists propose studies of extraction of only about four percent of the total available energy--about 1,000 megawatts, the output of a single large nuclear station. Significantly larger amounts continuously taken out might seriously alter the Gulf Stream flow patterns and disrupt climatic conditions to the north and east.

The "windmills" suggested by the scientists would be large, slow turbines which resemble windmills in that they have a relatively small number of slanted blades arranged circularly around a central shaft--as contrasted with a high-pressure steam turbine which sometimes has hundreds of blades. For 1,000 megawatts' generating capacity, the scientists suggest that about 200 of the turbines could be arrayed across part of the channel between Florida and Bimini at depths between about 100 and 400 ft.

The turbines would be enclosed in housings, one end open toward the current. Each turbine would have its own generator, and cables anchoring the turbine-generators to the ocean floor would also carry the power generated to a master cable on the bottom. The entire array would be in a line about 12 mi long and perpendicular to the current.

Velocity profiles of the Florida Current show that the maximum velocity occurs in the upper 400 ft--thus dictating the vertical emplacement of the turbines in this range. At the same time, the machines would have to be below wave action and ships plying the channel.

The costs of the turbines might be very high, because of the relatively low energy density in the Gulf Stream, despite its large total energy. Engineering and economic feasibility have not been proven, but the energy available is large enough to be more than casually interesting.

The scientists also suggest that electricity produced and not used directly in the Miami area could be used to dissociate water into its component hydrogen and oxygen. These products could then be cooled and liquified for shipment to conventional power plants where they could be burned to produce power. Since the product of this combustion would be pure water, there would be no pollution. Alternately, space-age fuel cells could convert the hydrogen to electrical power.

DATA BUOYS SURVIVE ARCTIC WEATHER

Several unmanned satellite-communicating, data-reporting buoys have drifted in the Arctic ice for more than 15 mo in a dramatic demonstration of their ability to operate effectively in one of the world's harshest environments (fig. 20).

By mid-July, two of six 340-pound buoys being tested in the icepack north of Alaska had continued to operate since April 1972, despite storms, drifting ice, temperatures of -50°F, and attacks by polar bears. Two remained operational for more than 13 mo before they ceased responding to satellite-relayed signals. Two operated for 2 1/2 to 3 mo. Another buoy, placed in the ice in October 1972, was still operating after 9 mo. The buoys were designed to operate up to 1 yr. (See the November 1972 issue of the <u>Mariners Weather Log</u> for additional information.)

The buoys provide environmental data on air pressure, temperature, and ice movements as they drift

Figure 20.--Transmitting environmental information to a satellite, this data buoy survived the rigors of the Arctic to demonstrate its capabilities under severe conditions.

about the Arctic Ocean.

The two operating buoys from the initial installation are in their second summer in the Arctic, the most critical period. This is the period when buoys may become free-floating and more susceptible to damage from collision or crushing by ice movement.

Buoys which operate successfully in the polar regions could play a major role in weather forecasting of the future, since much of the world's weather develops in the Arctic and Antarctic. A system of buoys regularly reporting meteorological data from these "weather factories" would provide an important assist to the nation's forecasters. They would complement those being tested now in the North Atlantic, Gulf of Mexico, and Gulf of Alaska. It is estimated that an array of about 30 buoys deployed from central

ice camps and shore-based facilities could rather uniformly cover the entire Arctic Ocean. Data from the buoys are transmitted to Fairbanks, Alaska, via NASA's polar-orbiting Nimbus-4 satellite.

SENSORS ON NOAA AIRCRAFT AND SKYLAB PROBE SUPERHURRICANE AVA; UNIQUE MEASUREMENTS OBTAINED

Scientists and sensors aboard a C-130 flying laboratory from NOAA and NASA's Skylab kept a rendezvous with Ava, the first storm of the eastern Pacific hurricane season and one of the most violent hurricanes on record for this area.

Preliminary assessments indicate that a unique set of hurricane wind and wave measurements was obtained during the short encounter with the superhurricane.

Scientists from the Miami, Fla.-based Atlantic Oceanographic and Meteorological Laboratories and the Research Flight Facility-intercepted the storm about 300 mi southwest of Acapulco as Skylab was passing overhead, and flew a series of tracks through the hurricane at altitudes ranging from 500 to 10,000 ft.

The June 6 aircraft penetration was one of a series of NASA-funded Skylab underflights to prove the effectiveness of measuring large-scale processes in and over the ocean surface using microwave and other sensors aboard such space platforms. The flights also provide an improved understanding of hurricanes and other atmospheric phenomena, and should help improve men's ability to predict, simulate, and modify them.

Although Skylab did not pass directly over Ava, the astronauts were able to obtain some data on wind and surface conditions from the Earth Resources Experiment Package (EREP), as the sensors are able to scan 300 mi to either side. Handheld photographs (fig. 21) were taken out of a spacecraft window. The EREP operation only lasted 5 min as Skylab passed closest to the hurricane.

Figure 21.--Skylab astronauts photographed hurricane Ava out of the spacecraft's window, as she kicked-up her heels off the west coast of Mexico.

Microwave systems similar to those aboard Skylab were installed on the C-130 to measure such surface parameters as wind speed and wave height. To provide a means of evaluating the microwave systems, an airborne laser altimeter also measured surface wave heights and an inertial navigation system on the airplane measured flight-level winds. These measurements will be used to verify the accuracy of similar, simultaneous observations made by the spacecraft from its orbit 270 mi above the earth's surface.

Hurricane Ava was a perfect natural laboratory for the sensor experiments. The storm's intensity and high degree of organization provided an almost perfect hurricane specimen.

The inertial navigation system on the C-130 is a big improvement in wind-measuring accuracy. Doppler systems can measure hurricane winds to within about 10 kt, but in areas of heavy precipitation such as a hurricane, the Doppler is frequently inoperative. The inertial system gives wind measurements to within a couple of knots, which provides a continuous detailed look at hurricane winds that simply was not available before.

The first deep-ocean wave measurements ever made under a hurricane with a laser altimeter were taken, and maximum wave heights of about 40 ft were measured, about 100 mi from the eyewall. The passive microwave system indicated an unexpectedly high percentage of foam on the surface, which tells quite a lot about how the storm winds and ocean surface interact under such conditions. These were the first radiometric measurements ever made of the sea surface under a hurricane. Microwave radiometry is a promising environmental sensing technique, because storm systems are transparent to some microwave frequencies, and because the microwave images reveal something about the texture of the surface being observed. The C-130 microwave systems are passive (they "listen" but do not send out a probing signal); one operates at the microwave radio frequency of 1.4 gigahertz (giga=billion, hertz=cycles per second), the other at 13 gigahertz. The water content of storm clouds is opaque at 13 gigahertz, but transparent at 1.4 gigahertz, permitting aircraft and satellite sensors to view ocean surface conditions beneath a maritime storm.

On the C-130, the 13-gigahertz system uses an 8-ft-diameter dish antenna which is deployed by opening the airplane's large cargo ramp (fig. 22) and swinging the antanna out to give it a clear view of the ocean surface. During the hurricane Ava underflight, this antenna was used only until the winds approached 50 kt; then the antenna was retracted and the cargo doors buttoned up for deeper penetration into the storm. Microwave instruments aboard Skylab essentially duplicated those aboard the C-130, with the difference that Skylab also carries an active microwave radar instrument.

Ava was also a first for the hurricane-hunting Research Flight Facility, which had never before flown a research mission into a Pacific hurricane. The aircraft entered the storm at about 500 ft altitude, flew to the band of 65-kt winds, then climbed to 10,000 ft, where it penetrated into the circular eye. Sustained winds increased from 60 to 130 kt over a line 10 mi long, an unusually steep gradient for a hurricane.

Figure 22.--Microwave antenna deployed from C-130 research aircraft to measure surface wind speeds and wave heights.

On June 6, an Air Force Air Weather Service hurricane-hunter reconnaissance aircraft reported a low pressure at the storm center of 915 mb (about 27 in of mercury), maximum winds of 130 kt, and a circular eye 15 mi in diameter. Subsequent wind measurements showed maximum winds of 137 kt. The unusually vigorous storm maintained hurricane strength from June 4 to June 9.

TWO OCEAN BUOYS MAINTAIN HURRICANE WATCH IN GULF OF MEXICO

Two large environmental data-gathering ocean buoys are now strategically deployed in the Gulf of Mexico, where they maintain a watch on hurricanes which may endanger the Gulf Coast.

The experimental 40-ft-diameter, 100-ton buoys are being tested and evaluated by the Data Buoy Office of NOAA, located at the NASA Mississippi Test Facility near Bay Saint Louis, Miss.

The buoys, designated EB-10 and EB-12, are two of five large buoys which occupy or will occupy ocean stations around the North American continent in the very near future. The buoys are moored in approximately 1 1/2 to 2 mi of water: the EB-10 since June 1972 in 8,292 ft, 225 mi south of Gulfport, Miss.; and its sister buoy, the EB-12, deployed last June, at a depth of 10,368 ft, 200 mi east of Brownsville, Tex.

The buoys are equipped to relay sea level barometric pressure, air temperature, precipitation, wind velocity, and sea-surface temperatures for use by climatologists and weather forecasters. The data are received by a Coast Guard station in Miami, Fla., and rebroadcast to NOAA's National Weather Service for use in weather forecasts and warning advisories. EB-12 is also equipped with underwater sensors which report conductivity (salinity), current velocity, water pressure, and water temperature at five different ocean depths.

The performance of the EB-10 has been especially noteworthy during the past year. This was demonstrated February 9, 1973, when a severe winter storm developed in the Gulf of Mexico. The storm later paralyzed much of the southeast with abnormal amounts of snowfall. According to the National Meteorological Center, the data were very useful in determining the start and intensity of the storm.

A March 24, 1973 storm that brought strong winds,

high water, and much damage to the Gulf Coast illustrated the ability of the EB-10 to survive and transmit useful environmental information during adverse sea conditions. Winds in excess of 55 kt and waves of 6 to 8 ft were reported along the Gulf Coast during the height of the storm. EB-10 reported data throughout the storm and assisted the National Weather Service in providing more accurate weather forecasts for the region.

Buoys similar to the EB-10 are deployed also in the North Atlantic off Norfolk, Va., and in the Gulf of Alaska.

PACIFIC SPEED RECORD SET

Sea-Land Service's containership SEA-LAND COMMERCE set a new trans-Pacific speed record for commercial ships when she arrived in Long Beach on July 6 from Yokohama, making the crossing in 6 days, 1 hr, and 30 min. The SL-7 class vessel cut by 1 1/2 days the previous record for the crossing. The ship averaged 33.26 kt for the 4,840-mi voyage.

The line's SL-7 vessels previously set speed records in both directions on the Seattle-Kobe and Seattle-Yokohama routes, as well as on the New York-North Europe route.

LETTERS TO THE EDITOR

STORM AT SEA, FEBRUARY 1973--NOAA Ship FAIRWEATHER

The following letter was received from the Commanding Officer of the NOAA Ship FAIRWEATHER, Comdr. Charles A. Burroughs.

"Enclosed you will find two narrative attachments, a graphic plot, and copies of two barograms relating to this ship's recent voyage from Seattle, Wash. to the Hawaiian Islands. Attachment 1, compiled by Lt. Comdr. Frank P. Rossi, together with the graphic plot and barograph records, relates the impact of the storm upon our voyage to Hawaii. Attachment 2 is an excerpt from my Monthly Activities Report for the month of February, describing this same voyage.

"The information is being submitted at this time, in the event that you might find it of some use in compiling your 'Smooth Log, North Pacific Weather' for February 1973."

Attachment 1 is quoted below. The significant part of the track on the graphic plot and the barogram trace for that area are shown in accompanying figures. Lt. Comdr. Frank P. Rossi is a former editor of the Mariners Weather Log.

"On February 20, 1973, the NOAA Ship FAIRWEATHER (fig. 23) departed Seattle for a planned 7-day voyage to its spring hydrographic survey project area in the Hawaiian Islands. After departing Cape Flattery under the influence of a large 1030-mb Pacific high-pressure system, the FAIRWEATHER experienced a steadily declining barometer for the next several days. This situation continued with corre-

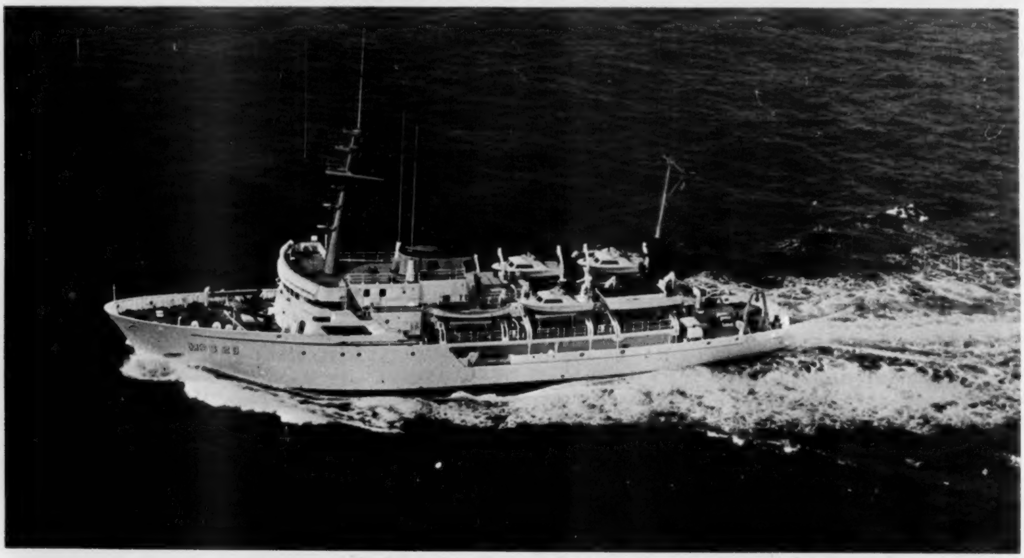

Figure 23.--The NOAA Ship FAIRWEATHER in much calmer conditions than those encountered on February 24-26, 1973.

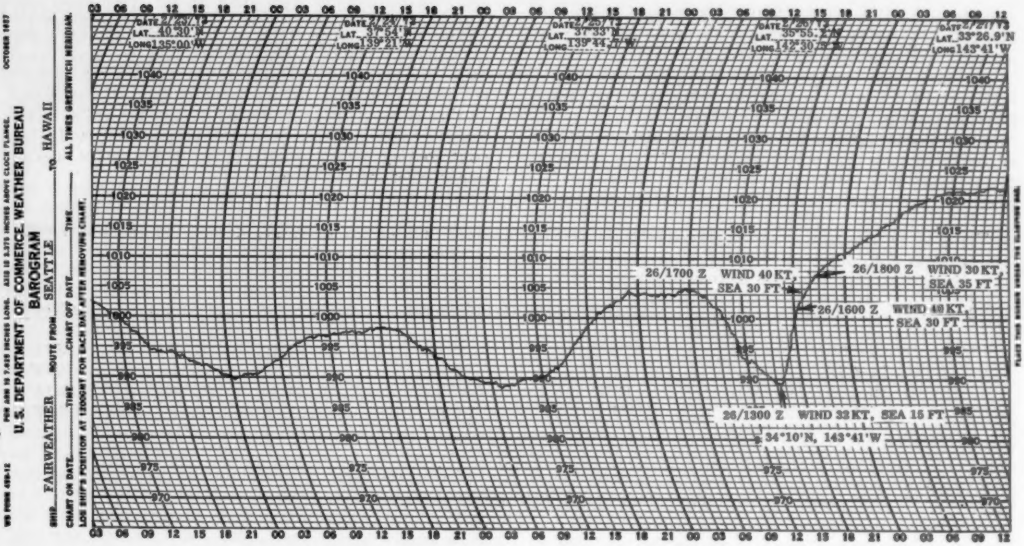

Figure 24.--Barogram with notations showing FAIRWEATHER's encounter with North Pacific storm of February 26, 1973. Comdr. Burroughs noted that the Barograph was maintained in the Commanding Officer's cabin strictly as an indication of trend of barometric conditions. It will be noted that some slippage in time had occurred. However, notations have been extracted from the Ship's Log.

sponding degradation of sea conditions, until a series of LOWS developed that dominated the eastern North Pacific from the 24th through the 26th (Mariners Weather Log, May 1973, pg. 195). Early on the 24th, the winds had increased to 40 kt, with 20- to 25-ft seas on the ship's beam. The heavy rolling forced the ship to head westerly for a more sea-keeping ride, as the heavy seas persisted. At 1300 on the 26th, a low pressure of 989 mb (the third of three distinct LOWS) was recorded (fig. 24). At this point, the ship was on a southerly course, headed into heavy confused seas, with the wind on the starboard quarter. The wind then began to increase at such a rapid rate that the course had to be altered gradually around to the west (fig. 25) in order to come into the increasing wind, which reached a sustained 40 kt, 3 hr later, with gusts to 60 kt and seas building to 35 ft by 1800. By 2100 the wind and seas had abated enough so the ship could continue to make good its course for Hawaii. This rough crossing took 10 days; but caused no ship damage other than the usual loss of crockery, the breaking away of a file cabinet, drifting books and papers, the loss of a ham radio antenna off the flying bridge, and a high percentage of upset and tired bodies."

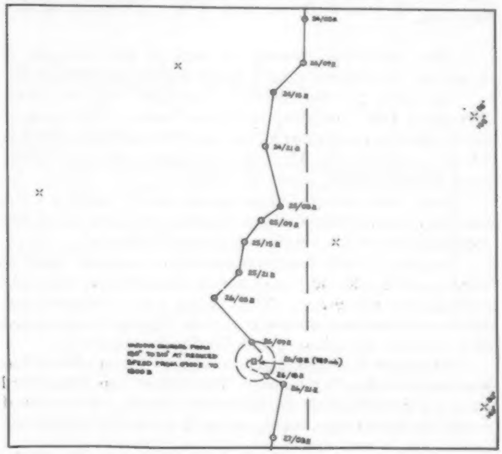

Figure 25.--FAIRWEATHER's track from 0300 February 24 to 0300 February 27, 1973.

ANOTHER REPORT OF DUST FAR AT SEA

This letter from P. C. Doerr of the EXPORT BUILDER was forwarded to the Mariners Weather Log by Walt Stoddard, the Port Meteorological Officer New York. This is the second item concerning dust over the Atlantic in the last several months. The July issue contains a report by the EXFORD on dust near the Cape Verde Islands.

"From June 12 to 15, while on the way from Durban to New York, we observed a phenomenon which the Master and Deck Officers decided would be of interest to you and therefore worth reporting.

"We are all familiar with dust storms in the Red Sea and Arabian Sea, but never, as far as we are concerned, in the middle of the Atlantic.

"After 3 days in a persistent haze, the unmistaken signs of dust were all over the ship, fouling up the Chief Officer's paint work.

"The Radio Officer did not fare any better. While he could receive the radio stations, our transmissions could not be received."

The meteorological pattern during the above period consisted of a large HIGH to the north and a LOW over the Sahara. The resulting surface and low-level winds over that area of the Atlantic were from the east and northeast, or from off the western part of the desert. At this time, a drought is also occurring in the Sudan, south of the Sahara Desert. This undoubtedly is a contributing factor to the winds picking up the dust and carrying it far out to sea.

Table 5.--Excerpts from the EXPORT BUILDER's logbook entries for weather, during the encounter with dust at sea.

Date	Position		Wind Direction	Wind Force	Barometer	Air Temp.	Sea Temp.
6/12/73	9-16N	34-11W	ENE	5-6 kt	29.94 in	82°F	83°F
6/13/73	14-08N	40-03W	ENE	5-6 kt	30.04 in	79°F	79°F
6/14/73	19-02N	45-47W	ENE	5-6 kt	30.14 in	79°F	80°F
6/15/73	24-24N	52-01W	E	4 kt	30.21 in	82°F	81°F
	True Course 311°						

ABNORMAL VISIBILITY AT SEA

The following letter was sent to the National Weather Service, Washington, D.C. The letter was also addressed to the Hydrographic Departments of England and Germany. The report from the MOBIL VALIANT was written by 2d Officer Horst Ramforth and signed by the Master. The letter was forwarded to me from the Marine Weather Service of the National Weather Service.

"The following report is sent to you because it might be of interest and a contribution to your work.

"On June 22, the MOBIL VALIANT was on a true course of 142°, heading for Cape Town. The unusual visibility was encountered between the positions 29.7°S, 14.4°E and 32.4°S, 17.2°E, and observed from 1600, June 22 until 0400, June 23, 1973.

"For background information on the state of the weather during these observations, an abstract of the logbook's weather entries is given (table 6).

"At about 1400, there appeared to be a low layer of what looked like fog just above the horizon approximately 10 mi away. The radar was switched on. While proceeding on course, the foglike appearance didn't come any closer, but finally disappeared.

"At about 1500, a radar contact was made on the starboard side, 18 mi away. The object was identified as a cargo vessel on an opposite course. The vessel could be seen very clearly when it passed at a distance of 10 mi. Shortly after the vessel had passed, its outlines suddenly changed. The superstructure and masts became indistinct and the ship looked like a dark, solid block.

"While that vessel was still visible at 18 mi distance and a good radar contact, another vessel came into sight at about 2 points off the starboard bow. The lights could be clearly seen at an estimated distance of 8 mi, but no radar contact was obtained from that ship. The radar being used was a Raytheon TM 1660/ 12 S Marine Pathfinder.

"The outlines of that ship also became indistinct, though obviously approaching. At about the same time, a third vessel could be seen about 6 points abaft of the port beam. Its lights could be clearly seen. However, this ship was also not contacted by radar.

"The radar picture only showed the vessel first mentioned. This first vessel was still visible with binoculars at a radar distance of 19 mi. The two other ships, visible for about 15 min, suddenly disappeared and were not seen again.

"A star fix taken by two officers from seven stars came out with useless results, although stars and horizon appeared good visually. While searching for the error that might have caused the useless results, it was found that if 10 min were added to the height of each observation, the results would have been correct.

"During the night, the sky was cloudless and the

Table 6.--Abstract of MOBIL VALIANT logbook weather entries.

Date	Time (GMT)	Wind	Barometer	Air	Sea	Weather	State of Sea	
June 22	1400	ESE 2	1014.2	18.0	15.5	b/c	1	long southerly swell
June 22	1800	Var. 1	1015.0	17.0	16.5	b	1	long southerly swell
June 22	2200	Var. 1	1014.8	15.5	16.5	b	1	long southerly swell
June 23	0200	Var. 1	1015.0	15.5	16.5	b	1	mod. southerly swell
June 23	0400	NE 2	1015.0	15.5	14.5	b	1-2	mod. southerly swell

stars were seen, bright and clear, but there was such a complete darkness that it was impossible to make out the horizon. Thus, it was not possible to estimate the existing visibility. Therefore, stars were reported as ships by the lookouts when just rising from the invisible horizon.

"At 2015 a radar contact was obtained from an object on the starboard side, 20 mi off. The object was a drifting fishing boat. Its lights came into sight when it was 17 mi away, thus indicating that visibility was normal.

"Because the ship was on the periphery of the South African Decca Chain (MP Namaca Chain 4a), the ship's Decca Navigator MK 12 was switched on. The Decca fixes were plotted, but not used for navigation because of the inaccuracy which might affect the Decca data, taken at night at such a distance from the stations. The deviation of the standard compass, obtained by running checks, was normal.

"At 0300 on June 23, a Decca fix was taken and combined with a radio direction finding from Radio Columbine. According to that position, the vessel was 70 mi away from Cape Columbine. At the same time, the beacon of the Doornbaai Lighthouse was seen and proved by the position obtained before. Thus, the light was seen from a distance of about 75 mi. The light was visible until 0400, and was checked with positions taken by Decca and bearings from Radio Columbine.

"According to the 'Admiralty List of Lights,' Vol. D, 1972, Doornbaai Lighthouse, Gp Fl (2) 10 sec, has a range of 15 mi.

"After sunrise, when making landfall, the visibility was back to normal."

Editor's Note: The MOBIL VALIANT appears to have encountered optical phenomena called looming and towering. Like mirages, looming and towering are the result of refraction of light rays, caused by a layer of air having an unusual temperature lapse rate and, therefore, rapidly changing density near the surface. The foglike appearance in the distance was probably the result of haze trapped by a low-level inversion. A thin layer could easily be seen through vertically, but not horizontally. This haze, with the refraction, could explain the lack of a horizon.

The two vessels that could not be seen on radar were probably many miles over the horizon and were visible due to the looming phenomena. This is indicated by their sudden disappearance, as well as the visibility of the Doornbaai Light from a distance of 75 mi. Refraction is definitely indicated by the star fix, and a careful check would probably show that the higher the elevation of the star, the less the correction required for an accurate line of position.

Towering is indicated by the change in appearance of the first vessel from distinct to an indistinct solid block. Also, the inversion and haze layer could have been lower in that area, with the ship's masts and superstructure actually in the haze.

MARINE WEATHER REVIEW

Smooth Log, North Atlantic Weather

March and April 1973

The SMOOTH LOG (complete with cyclone tracks [figs. 29-32], climatological data from U. S. Ocean Station Vessels [tables 7-10, 12] and gale tables 11 and 13), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

SMOOTH LOG MARCH 1973--For the first week and the last several days of the month, high pressure was the dominant feature of the western North Atlantic. High pressure, in general, was predominant over the eastern North Atlantic. Cyclone activity was below normal and the tracks diffuse. A primary track could be said to exist from Nova Scotia to across Iceland, and another possibly from James Bay across Kap Farvel and up the Denmark Strait. Several cyclones formed in and tracked across the Mediterranean area. There was more activity than usual in the central North Atlantic. Cyclone activity was weaker than normal throughout the area with fewer storms along the U.S. Atlantic coast. One severe Atlantic coast storm, however, made up for the others that were not present.

The March mean sea-level pressure chart was quite different from the climatological mean chart for the month. The 1000-mb Icelandic Low was centered between Kap Farvel and Iceland, about 350 mi northeast of its usual 1005-mb position. The trough which normally extends to the northeast was deeper and oriented more northerly this month. A 1027-mb high-pressure center was located over the English Channel. The ridge from this High extended over the Azores with several centers along 30°N across the Atlantic. A 1019-mb high-pressure center was over northern Greenland. There were two small 1020-mb centers in Canada near James Bay. The pressure over the eastern half of the United States was near normal, except slightly higher in New England.

The more significant anomalies this month were the positive, rather than the negative. The largest was a positive 12 mb, centered over southern Ire-

land. A plus 8 mb was centered over Nova Scotia. This is even more anomalous in that a primary storm track passed over Nova Scotia. This can be explained by those LOWS passing through the area not being as deep as usual. A negative 7-mb anomaly occurred in the Denmark Strait. As a matter of interest, a negative 10 mb was centered near the North Pole. A tongue of low pressure extended from that center across the Svalbard Islands to the minus 7-mb center between Kap Mosting and Iceland. As the storm tracks indicate, a large area with a negative 6-mb anomaly was located in the Texas-New Mexico-Oklahoma area.

There were no tropical storms or hurricanes in the North Atlantic.

The first half of the month was relatively quiet across the Atlantic. There were several low-pressure systems, but none really generated into storm producers. Gale-force winds were reported in or around most of these systems, but in only two isolated instances, were winds as high as 50 kt plotted on the charts. Gale tables made later from weather reports mailed to the National Climatic Center indicated more winds of storm strength and greater.

The first storm of the month that appears to be worth describing originated as a small 1002-mb LOW on the south coast of Maine on the 12th. By 1200 on the 13th, it had incorporated the circulation of an older system that tracked out of the mid-United States. The pressure had plummeted to 974 mb, and the center was located slightly northeast of St. John's, Newfoundland. The ATLANTIC FOREST, 600 mi south of the center, had 40-kt gales. The LOW continued to deepen, but remained almost stationary in the vicinity of 50°N, 50°W. It was now the only major cyclonic system in the North Atlantic. The highest winds during this time were reported as 40 kt by SEDCO I.

On the 15th, things started to pick up, as another 1002-mb LOW developed near 37°N, 45°W in the trough associated with the above LOW. This tightened the gradient in the area, particularly west of the center. Five ships reported 35-kt gales, and the AMERICAN TRADER and HOEGH ORRIS were buffeted by 40-kt gales northwest and southwest, respectively, of the new center. About 250 mi due west, the BELGRAD experienced 50-kt winds. Twenty-four hours later, at 0000 on the 16th, this center had moved north-northeastward with a central pressure of 984 mb, near 45.5°N, 35.0°W. A stationary HIGH was centered over Ireland, and a strong wind band was created ahead of the front between the two systems. The C. P. TRADER and the WESER EXPRESS both encountered 40-kt gales.

At 0000 on the 17th, the two LOWS combined near 51°N, 38°W. The central pressure increased as the LOW made a cyclonic loop off Newfoundland and disappeared from the charts on the 19th.

This storm's major feature involved the Great Lakes. It developed as a wave on a front in Mississippi early on the 16th. At 0000 on the 17th, the LOW was in central Kentucky at a 996-mb pressure. A broad area of cyclonic circulation had started to develop. At 1200 on the 17th, the 980-mb LOW was centered near Cleveland and the winds were causing havoc to shore areas throughout the Lakes. Added to this were

Figure 26.--This cottage was destroyed by the high waves on Lake Ontario. Many low-lying areas on both the United States and Canadian sides suffered heavy damage. Wide World Photos.

blizzard snow conditions, with many inland areas receiving over 10 in. with drifts of 4 to 6 ft. Winds from the northeast through the northwest with speeds of 30 to 50 kt were recorded from Lake Ontario to Lake Michigan on the 17th and 18th. Estimates of 60 kt were given on Lake Huron. The Coast Guard received reports of waves of 8 to 12 ft; the highest at Erie, Pa., of 10 to 12 ft. Water in Saginaw Bay and River was 7 ft above normal and extended as far as 5 mi inland. The record high water levels of the Great Lakes added to the destruction and flooding from the winds and waves. Because of the time of the year when ships have not started to operate, no ship reports were received. The first shipping through the locks and canals started on March 28.

Millions of dollars worth of damage was incurred to property (fig. 26), and thousands of people were displaced from flooded and damaged homes. It was estimated that this storm was more destructive than the November 14-15, 1972, storm. See the March 1973 issue of the Mariners Weather Log for a description of this storm.

Back at sea on the 17th, the ESSO BOSTON was lashed by 40-kt gales off Charleston, and, on the 18th, Ocean Station Vessel "H" was pounded by 40-kt winds and 23-ft seas. At 0000 on the 18th, the 972-mb LOW was over Kingston, Ontario. Later on the 18th, the following ships reported winds from 40-kt gales to 55-kt storm, from Nova Scotia to Charleston, S.C.: BALTIMORE TRADER, ESSO PUERTO RICO, ESSO WASHINGTON, FORT DE FRANCE, GOWAN BANK, MOBIL POWER, USNS MAUMEE, and VGBZ. The GOWAN BANK reported 19.5-ft waves and 29.5-ft swells at 36.9°N, 70.7°W. On the 19th, a second LOW developed south of Newfoundland to the east of the parent LOW. The strongest winds remained just off the coast where the ATLANTICA MARSEILLE, DONGA, GYPSUM QUEEN, and RU YUNG were buffeted by 40-to 45-kt gales, driving seas, and swells up to 30 ft. The BALTIMORE TRADER was pounded by 55-kt winds, accompanied by 19.5-ft waves and 24.5-ft swells 40° off the sea wave direction.

The easternmost LOW took a northeasterly track and rapidly moved over Iceland, on the 21st, to disappear in the Barents Sea. The original LOW moved over Newfoundland, on the 20th, prior to curving southeastward for 24 hr. Starting on the 22d, the storm gained new energy. Ocean Station Vessel "D" combated 50-kt winds as the center passed north of its station. The SERAFIN TOPIC measured 80-kt hurricane-force winds at 48.3°N, 35.4°W. This was about 100 mi southwest of the center. Six hours later, she was still measuring 72-kt winds, and the waves had increased to 39 ft. Twenty-four hours after that, her winds dropped to 42 kt, with 30-ft seas, as she headed due east. By the 23d, the pressure had dropped to 972 mb and the circulation had expanded considerably. At 1200 that day, the center was at 56°N, 22°W and the BREITLING, at 51.5°N, 27.5°W, about 300 mi to the southwest, wrestled with 50-kt northwesterlies. As the LOW moved over the pressure ridge protecting the European land mass, Ocean Station Vessel "J" was torn by 40-kt gales and confused waves. She was tossed by wind waves from the northwest of 33 ft, with swells of 23 ft from the north and 13 ft from the west. The KRPAN, further south, about 700 mi from the center, had higher winds of 50 kt but calmer sea and swell waves. As the storm moved across the top to Scotland it rapidly deteriorated and, by the 26th, was only a trough line on the weather charts.

Monster of the Month--This superstorm, which apparently caused the sinking of two ships, had its beginning in that incubator of storms--the Texas, Oklahoma, New Mexico area, A low-pressure area (1002 mb) consolidated, on the 19th, in Oklahoma and started an easterly track. A warm front extended to the east and a cold front to the south. The center moved steadily eastward at about 20 kt with little change in intensity, until late on the 21st, when it crossed the coast near Cape Hatteras. Here is where things happened. At 1200 on the 22d, the LOW was down to 984 mb, near 37°N, 70°W, and ships knew it was in the area. At 0000 that day, Ocean Station Vessel "H" was battered by a 50-kt easterly wind. The CHARLESTON, about 50 mi northeast of the center, was buffeted by 45-kt gales, 13-ft seas, and 13-ft swells. That was only an appetizer for later. The NIKOLAI DANILOV was engulfed in moderate snow blown by 60-kt winds about 70 mi off Cape May. At 1800, Ocean Station Vessel "H," about 65 mi west of the center, radioed a report of 70-kt hurricane-force winds from the north. At that time, the seas were running at 28 ft at her position. It has been reported that the GRESHAM (Ocean Station Vessel "H") suffered winds in excess of 65 kt for a period of 8 hr. Gusts were up to 88 kt. Seas averaged 30 ft, but many 50-ft seas were observed. The lowest pressure observed was 985 mb. The ship sustained structural damage, including the loss of several lifeboats. Additionally, some crewmembers were injured, with one requiring evacuation by helicopter. The Environmental Buoy (EB-01), off Norfolk, reported only 40-kt gales.

The NORSE VARIANT, a 13,194-ton Norwegian freighter, sank 130 mi southeast of Cape May (approximately 37.4°N, 72.8°W) at about 1800 on the 22d. She radioed that she was sinking and the 30 crewmen were taking to lifeboats. There was a report that a hatch had broken open. Coast Guard and Navy ships, and Air Force search and rescue aircraft all combed the area for survivors. On the 25th, an Air Force search aircraft spotted seaman Stein Gabrielsen, 23, in a liferaft 250 mi southeast of Cape May, N.J., more than 100 mi from where the ship went down. He had survived 3 days on the raft in raging seas with 40-ft waves and 70-kt winds. Two paramedics parachuted into the sea to Gabrielsen's aid. He was put aboard the MOBIL LUBE. A Coast Guard helicopter picked him up from the tanker and transferred him to the aircraft carrier INDEPENDENCE. He was reported in good health. Six ships and four aircraft continued the search, but no other survivors were found. For a later, more detailed account, see the 7/8:73 Amver Bulletin.

The Norwegian motorvessel ANITA, also carrying a cargo of coal, has been missing since March 21. The vessel was reportedly in the same area as the NORSE VARIANT when she sank in the violent storm. The ANITA carried a crew of 29. At last reports, no survivors or other evidence of her fate had been found, but a lifering bearing her name was recovered.

As the storm churned up the coast, many ships felt its wrath. Fifty-knot winds or greater were reported in the semicircle from 500 mi to the northeast to the coast, to 440 mi to the southwest, early on the 23d. Among them were the USCGC CAMPBELL,

PORTLAND, VASSIUI SOURIKOU, VGBZ, and the WEWW. The VODB was blasted by 60-kt winds and 30-ft seas about 160 mi east of Wallops Island, Va. Nearby a ship reported being ravaged by heavy rain, 65-kt hurricane-force winds, and 40-ft seas. Twelve hours later, at 1200 on the 23d, the storm was fixed by aircraft reconnaissance at 38.0°N, 64.5°W with a pressure of 971 mb. At that time the strongest wind reported was 60 kt by the USCGC ACTIVE and USCGC CAMPBELL in the north and northwest quadrants of the storm. Gale- and storm-force winds extended up to 600 mi in all quadrants. The highest sea and swell was 33 ft in the northeast and southeast quadrants. The Outer Banks of North Carolina took another beating for 3 days. At least five motel units and two beach cottages were destroyed. A February storm also wrought havoc in this area. Considerable flooding and beach erosion again occurred.

The LOW was tracking almost due east, and at 0000 on the 24th, was near 38°N, 61°W, at a pressure of 972 mb. It was still a vicious storm as the ATLANTICA NEW YORK could attest as she was rocked and rolled by 70-kt hurricane-force winds and 30-ft swells from the north-northeast on her 10-kt westerly course. Her position was 40.3°N, 64.0°W or about 210 mi northwest of the center. The AMERICAN LEGEND was pounded by 55-kt storm winds, with 23-ft seas, at 40.6°N, 67.1°W. The WARRIOR, at 39.8°N, 64.7°W, was also hammered by 55-kt winds, 6 hr later at 0600, but to compound her misery, she suffered 15-ft waves atop 39-ft swells. Later on the 24th, the storm hatched a secondary LOW to the northeast of the center and the central pressure started to rise. This weakened the circulation, and 45-kt winds were the maximum plotted. The storm now turned northeastward and, as it encountered colder water, it rapidly dissipated and was buried at sea on the 26th north of Ocean Station Vessel "D."

On the 25th, a high-pressure center moved off the U.S. East Coast. A LOW was located in the midwest. As the systems moved eastward, the ESSO HUNTINGTON, near 34°N, 75°W, was buffeted by 45-kt gales. Twelve hours later, at 1200 on the 26th, the LOW split into two centers and the frontal system moved over the coastline. In the tight pressure gradient ahead of the front, Ocean Station Vessel "H" experienced 45-kt winds and the USNS SAUGATUCK reported 40-kt gales. As the HIGH moved eastward, the LOW that formed near Norfolk moved to the northeast up the slope of the Bermuda High and into the Norwegian Sea, on the 30th; it had little effect on shipping.

At 0000 on the 28th, a 994-mb LOW formed in the trough near 34°N, 68°W. Another HIGH was pressing in from Canada resulting in a dumbbell-shaped LOW. At 0000 on the 28th, Ocean Station Vessel "H" was agonized by 50-kt winds, now from the opposite direction--the northeast. The H 1070, USCGC ACTIVE, and the VGBZ, all reported 45-kt gales. The high-pressure area off Bermuda was now breaking down into the main circulation of the Azores High, and the LOW moved eastward. For the next 24 hr, the ATLANTICA MARSEILLE was treated to 45- and 50-kt headwinds and seas to 23 ft. The Canadian High moved across the top of the LOW on the 28th and 29th. On the 31st, the LOW split into two centers again. The 7,891-ton Greek-registered KIMOLOS was driven aground at the entrance to St. Pierre and Miquelon off Newfoundland. The LOWS were now fenced in on three sides by high-pressure areas. One moved northeastward and was absorbed on April 1. The other meandered in the vicinity of 37°N, 52°W until April 2.

Casualties--Besides the two ships that sank in the Monster of the Month, the following casualties occured. Caught in a gale in western Turkey, the 11,511-ton German tanker, T. P. A. O. I., grounded at Aleaja Bay and the 7,375-ton Turkish freighter MUSTAFA grounded in Tekudag, Sea of Marmara. The HENRY FORD II was stuck in ice 4 mi from the Detroit River Light. The 12,039-ton MANCHESTER CHALLENGE for Montreal ran aground in ice on March 8 near Buoy 68L in the St. Lawrence River. The 8,101-ton Italian motorship GALILEO FERRAIS ran aground in strong winds when entering the Port of Sardinia. The 2,124-ton NONNO UGO ran aground during high winds off Savudrija Point in the Adriatic Sea, on the 8th. The British ASIA FREIGHTER, under tow, was making little progress due to heavy weather. The Greek tanker (8,886 tons) ELEFTHERIA was aground when a sudden storm caused the vessel to bump against a jetty at Yarimca in the Gulf of Izmit, Turkey, on the 19th. Pushed aground when she lost power and steering in Lake Maracaibo, was the 17,539-ton British tanker GOLDEN TOBIN. Ice damage to the bow plating was sustained by the Greek motorvessel SPARTAN BAY in the Gulf of St. Lawrence.

SMOOTH LOG, APRIL 1973--It is to be expected that the storm tracks during April would be diffuse, as spring is the time of change and unsettled conditions. This month really lived up to that expectation. Normally a major storm track exists across the Great Lakes to the Strait of Belle Isle, and then into the Davis Strait. Another major storm track originates off Cape May, N. J., and extends across the Grand Banks to south of Iceland, then into the Norwegian and Barents Seas. In the Mediterranean Sea area there are tracks out of the Bay of Biscay and Algeria. The storms this month followed none of these tracks and in general were weak.

The storm track across the Great Lakes into the Davis Strait did not exist. The number of cyclones with their genesis in the southeastern United States were below normal and did not follow the usual pattern. Two tracked up the east coast to disappear in Canada. One tracked off the coast near Norfolk, over the Grand Banks, and then into the Davis Strait. No storm originated over North America and tracked across the Atlantic intact. One LOW did generate off Nova Scotia and traveled to the United Kingdom. There was quite a flurry of activity in the central North Atlantic, but, in general, these cyclones looped around and dissipated in the same area. This is evidenced by the pressure anomaly pattern. One LOW managed to track into the Norwegian Sea, one into France, and one approached Gibraltar.

The 30-day mean sea-level pressure chart did not resemble its climatological counterpart. Normally the Icelandic Low, at 1007.5 mb, is centered about 100 mi southeast of Kap Farvel, and is an elongated teardrop shape from Newfoundland to Norway. A large 1021-mb High, centered near 30°N, 40°W, dominates the southern central ocean.

This month the "Icelandic Low," if it could be said to exist, was split into two parts: a 1008-mb Low centered near 45°N, 45°W, and a 1007-mb Low centered over Scandinavia, near 65°N, 18°E, with a 1027-mb High sandwiched between them near 54°N, 21°W. The Bermuda-Azores High was near normal in configuration, except the center was shifted 12° longitude westward and was 2 mb lower in pressure.

It is almost superfluous to state that the anomalies were large. A positive 17-mb anomaly, centered near 56°N, 27°W, with a 12-mb offspring over central Greenland, dominated the waters north of approximately 45°N. A negative 6-mb anomaly was located over the Baltic Sea, and a negative 7-mb anomaly was centered near 39°N, 40°W in connection with the abnormal cyclone activity in that area.

The Atlantic this month was rather pacific. There were several individual LOWS that generated gale-force winds of 35 to 45 kt for short periods of time, especially as they moved off the coast. This also applied to the Denmark Strait and Norwegian Sea areas.

The first storm worthy of description caused some slight concern to a few ships. A 999-mb LOW developed in northern Mississippi, and was first seen on the 0000 chart of the 4th. A warm front stretched across northern Florida to a wave just south of Panama City. The cold front extended southwest toward Vera Cruz. The INGER, at 25.5°N, 92.5°W, reported 40-kt gales behind the front. The LOW moved northeastward, consolidating, and by 1200 on the 5th, was off the coast of Maine. On the 5th, the ESRL and VGBZ both reported winds of 40 kt, ahead of the occlusion. The MOBIL POWER off Cape Hatteras and the MOBIL VALIANT off Cape Henry both reported 45-kt gales. The LOW, now down to 978-mb pressure, was over the Gulf of St. Lawrence at 1200 on the 6th. The DAWSON, DILOMA, and Ocean Station Vessel "B" all received 35-kt gales.

At this time, the storm's advance to the north was slowed considerably as it churned against a very large HIGH over the Northwest Territories and Greenland. The area of cyclonic circulation had expanded and the DAWSON, USCGC ESCANABA, and Ocean Station Vessel "D" battled 40-and 45-kt gales, on the 7th. The ESSO GLOUCESTER, near 38°N, 61°W, which was about 720 mi south of the LOW, was buffeted by 50-kt winds, and had both sea and swell waves of 23 ft. Late on the 6th, a closed HIGH broke off the ridge that extended southeastward from Greenland. The gradient across the northern half of the LOW was now very tight. The C. P. TRADER and Ocean Station Vessel "C" had 40-kt gales in midocean, and the DAWSON, now 200 mi south of Cape Sable, was buffeted by 45-kt gales and 15-ft seas on the 8th.

The two high-pressure areas on each side of the LOW were slowly slipping southward, and the LOW was slowly eroding the ridge between, and moving northward. Another low-pressure wave moved off Cape Hatteras, on the 8th, to begin sapping the strength of this storm. By 0000 on the 10th, the LOW had managed to arrive at Ungava Bay, and was turning

Figure 27.--Spray from gale-driven waves reaches above the first-floor lobby as it smashes into the side of an apartment building on the shore of Lake Michigan. Wide World Photos.

toward the west and filling. It managed to bring gale-force winds to several stations along Baffin Island, but was finished as far as shipping was concerned. By 0000 on the 11th, all that remained was a trough associated with the LOW that had moved up the coast.

This LOW formed in the Gulf of Mexico, south of Galveston, Tex., on the 7th. Although it appeared very anemic with only a closed 1004-mb isobar, the DOCTOR LYKES, at 28°N, 93°W, and the EXXON JAMESTOWN, at 26.5°N, 93°W, were both on the receiving end of 40-kt gales. They both reported 10-ft seas, and the DOCTOR LYKES also found 20-ft swells.

The LOW moved onshore near New Orleans later that day, and was over Cape Hatteras 24 hr later. The rapidly moving storm was near 39.5°N, 63.8°W, at 0000 on the 9th, with a pressure of 990 mb. The BAFFIN, about 150 mi southeast of the storm's center, had 45-kt southerly winds, and the DAWSON was battered again, this time with 50-kt northeasterlies and chilling rain. Twelve hours later, it gave the FRANCE shifting winds of up to 50 kt, as it passed a few miles northwest of her position. On the 10th, there were three reports of 40-kt gales to the south and southwest of the center, which was about 300 mi off St. John's, Newfoundland. As the LOW curved northward toward the Davis Strait, it lost its forward momentum, and another LOW, moving northeastward up the U.S. East Coast, started absorbing its circulation on the 11th. It survived as an identifiable entity until the 14th.

This cyclone's claim to fame involved the Great Lakes. It generated on a front in Arkansas on the 9th. It intensified rapidly from a wave at 0000 to a large, closed 989-mb LOW at 1200. As it moved northeastward through Missouri into Illinois, northeast winds played havoc on the Great Lakes. Gale-force winds driving high waves lashed the shore of Lake Michigan (fig. 27). As the storm moved over northern Indiana on the 10th, it weakened, and another LOW moving up the U.S. East Coast was destined to take the spotlight; but not before further havoc was brought to the western shore of Lake Erie (fig. 28) and Lake St. Clair. Storm warnings were posted for Lake Huron. This April storm left deep snow and record low temperatures in many areas. By 0000 on the 11th, the East Coast LOW was the major circulation feature.

A weak front between two HIGHS lay several hundred miles off the U.S. East Coast on the 14th. These two high-pressure areas were the dominant meteorological features from Europe to the U.S. Rocky Mountains.

Figure 28.--This home was swept from its foundation by the waters of Lake Erie. This is only an example of the destruction along the shores of Lakes Erie and St. Clair. Wide World Photos.

A frontal wave formed on the front near 36.5°N, 64°W, and by 0000 on the 14th had a closed circulation. The LOW deepened fast, 1 mb/hr, for the next 12 hr, and the MEZADA had 45-kt winds as the center passed almost directly over her position, near 36°N, 61°W. The EXPORT AIDE, at 37°N, 54.2°W at 0600 on the 15th, must have thought the hurricane season had started early when she was hit by 64-kt winds south of this extratropical LOW's 996-mb center. The LOW was moving northeastward, parallel to the tracks of the previous storms, but farther to the east. At 1200 on the 15th, the RHEIN EXPRESS, about 150 mi west of the center, was whipped by 50-kt winds on her bow, with 20-ft seas and swells.

On the 16th, the 990-mb LOW was headed toward the north off Newfoundland, and four ships reported gale-force winds. Near 50°N, 45°W, it paused. A ship passed very near the center, and on the southwest side was treated to 50-kt starboard winds. On the 17th, Ocean Station Vessel "D" was lashed by 45-kt gales and 21-ft seas. The LOW was rapidly filling and at 1200 on the 18th was up to 1010 mb, when a second LOW developed 450 mi to the south, and became the primary feature. This LOW moved southeastward, south of the Azores Islands. It deepened to only 1006 mb as it moved toward the Strait of Gibraltar, and was assimilated in the circulation of a LOW over Algeria.

A LOW formed in a col area south of Newfoundland on the 20th. It moved northeastward, and on the 22d was near 49°N, 44°W. Six hours earlier another LOW had formed near 39°N, 46°W, and was moving northward. This one was to be the dominant one, and by 1200 on the 22d, it had dropped 22 mb to a pressure of 970 mb at 46.5°N, 43°W. The C. P. AMBASSADOR, about 75 mi east of the center, combated 60-kt storm winds accompanied by 28-ft seas and 30-ft swells.

At 2245 on the 22d, the C.P. AMBASSADOR sent an SOS. The ATLANTIC CINDERELLA was the first on the scene. When the abandon ship order came, the crew elected to board the BUCHENSTEIN (18 crewmen) and the HERWIG (10 crewmen), because of the high freeboard of the CINDERELLA. The USCGC CHASE arrived at 0900 on the 23d. The crewmen were ordered into lifeboats when the engine-room of the C. P. AMBASSADOR began to flood. One man, a 65-yr-old veteran, making his final voyage, went into shock and had to be brought aboard in a stretcher. The men had been in the boat only about 3 hr, but the weather rendered them almost helpless. Their hands were numb, preventing them from climbing the ladders and nets of the BUCHENSTEIN. Lines were lashed to each man, and they were inched aboard the rolling BUCHENSTEIN one by one to receive hot drinks, warm showers, and blankets. The Captain and Chief Engineer of the C. P. AMBASSADOR stayed aboard their ship, and it was taken in tow by a tug. Their problems were not over. On May 1, they reported being in heavy ice, 250 mi east of St. John's, Newfoundland. The ice conditions remained bad, and they became stuck in the ice about 20 mi from St. John's. The icebreaker D'IBERVILLE went to their assistance, and the C.P. AMBASSADOR arrived in St. John's on the 4th.

Further east, the MANCHESTER CONCORDE was headed east-northeast with 45-kt winds from the southeast. On the west and southwest side of the LOW, south of the Grand Banks, the DART AMERICA, the SEDCO I, and the SLIEDRECHT were regaled with 35 to 45-kt winds.

Twelve hours later, 0000 on the 23d, there were eleven reports plotted on the weather chart of gale-force or greater winds. They were in all quadrants of the storm. The SUGAR PRODUCER, southeast of Cape Race, struggled with snow driven by 50-kt winds and confused seas. Wind waves of 16 ft were from 300°, 25-ft swell from 320°, and 16-ft swell from 270°. At 1200 that day a second LOW developed on the front and the two started to rotate around each other. The original LOW completed a counterclockwise loop early on the 24th. Gale-force winds still existed, especially on the flat side of the dumbbell-shaped storm. The secondary LOW dissipated on the 25th and the storm, now caught in the upper air zonal flow, started to move eastward across the Atlantic. The EL LOBO to the north and the WILHELM BORNHOFFEN to the west reported 40-kt gales. The storm moved north of the Azores into the Bay of Biscay on the 28th, and from there into the continent.

This LOW is interesting, if for no other reason than its longevity. The storm was born on the 24th off Nova Scotia, and died on May 6 over Scotland. As it followed the previous LOW across the Atlantic, it slowly deepened and expanded its circulation. The first gale-force winds were reported on the 27th when the center was located near 40°N, 41°W.

At 1200 on the 29th, the LOW was located near 40°N, 31°W, with a central pressure of 991 mb. The PENCHATEAU, near 30.5°N, 44.5°W, many miles to the southwest, braced against 50-kt winds, and the C. P. TRADER, 450 mi to the west-northwest, was rolled by 40-kt crosswinds for over 12 hr. On the 30th, the SATSUMACORE, to the north of the LOW, also found the 40-kt wind band.

The storm passed over the Azores Islands on the 30th, and turned northeastward. The pressure gradient between the LOW and the Moroccan Coast had tightened, and the Madeira Islands reported 35-kt gales. A ship between the island and the coast was pounded by 50-kt winds.

On the 2d the LOW passed between Ocean Station Vessel "K" and Cabo Finisterre. On the 3d, it slowed in its northerly track toward Ireland. As it passed almost directly over the ARGUS, she was swept by 40-kt gales. The storm was now filling, and combined with another LOW on the 6th, as it passed over Scotland.

Casualties--The 1,934-ton AMBERLEY was abandoned near 53.2°N, 1°E on the 2d. The crew was rescued. The ARGO LEADER, a Liberian registered vessel, sustained a 2-m crack in her forepeak, due to ice, 220 mi south-southeast of St. John's on the 5th. Also on the 5th, the SOUTHERN STAR was trapped in ice 180 mi east-southeast of St. John's. The Yugoslavian tanker IZ (12,770 tons) called for icebreaker assistance on the 7th, after being holed by heavy ice 170 mi east of Gander. The icebreaker D'IBERVILLE proceeded on the 10th to aid the vessel, and escorted her to the open sea. The German motor vessel OSTERFEHN (1,597 tons) reported at Boston with heavy weather damage. The DINO (986 tons) sank off Sardinia on the 9th. Her crew was rescued. On the 20th, the 647-ton JONRIX, of British registry, sank in heavy weather off Dunkirk. The crew was safe.

The British vessel GOLDEN ROBIN arrived at Holyrood, Newfoundland on the 26th with bow damage due to ice. The Mexican JALAPA (2,314 tons) sustained ice damage on a New York to Sydney, N.S. voyage.

Smooth Log, North Pacific Weather

March and April 1973

SMOOTH LOG, MARCH 1973--Cyclone activity in the North Pacific, overall, was above normal. Nearly all LOWS traversed the primary track from Japan, northeastward to the Bering Sea and the Gulf of Alaska. The more severe storms, except for one, seemed to favor the more westerly path into the Bering Sea. The LOWS that normally move out of Siberia across Sakhalin Island were further south and tracked across Korea and Japan where they joined the primary track originating south of Japan. LOWS from the Gulf of Alaska into the North American west coast took a more southerly direction and crossed the Oregon and California coasts rather than the British Columbia coast. The two secondary tracks that climatologically originate off the U.S. coast and then cross the coast, were absent.

The monthly mean sea-level pressure chart closely resembled the climatic chart in configuration, but the mean values were more extreme. The Aleutian Low had a mean pressure of 992 mb--13 mb deeper than the 1005-mb climatological value. The center was located at 50°N, 170°E, which was 180 mi southeast of its normal position. The Pacific High, at 1031-mb pressure, was 9-mb higher than the 1022-mb climatological High. The centers very nearly coincided. The Siberian High was 6-mb greater than average with a cutoff High center over the Cherskiy Mountains. The mean pressure along the U.S. West Coast and over Japan was near normal.

There were two major negative anomalies. The first, a minus 13-mb, coincided with the Aleutian Low center. The second, a minus 10-mb, was centered over Cordova, Alaska, in conjunction with the overall lower pressure for the month. Two major positive anomalies also resulted from the month's weather patterns. A plus 10-mb was associated with the Pacific High. The other, a positive 6-mb, resulted from the cutoff HIGH over Siberia. The pressure over Siberia, in general, was slightly higher than climatology indicates.

No tropical storms occurred in the North Pacific this month.

The first storm of the month had its beginning off Korea, near 38°N, 129°E, on the 4th. Within 24 hr, the pressure had plummeted to 990 mb, and the center was 400 mi east of Tokyo. The LA SALLE, at 32.9°N, 152°E, was hammered by 60-kt winds and 30-ft seas. By 1200 on the 5th, the 971-mb center was at 36.5°N, 157.5°E. One hundred miles ahead of the LOW, the WASHINGTON MAIL, which had previously been cruising through fog, now was buffeted by 50-kt winds with seas and swells of 33 ft. The LOW had raced north of the MALLORY LYKES, treating her to 45-kt gales near 28°N, 151°E. The LOW's circulation was spreading rapidly as the SILVER ARROW, south of Tokyo Bay, reported 45-kt winds. The GRAND INTEGRITY and the OCEANANAJIN collided in Yokohama Outer Harbor due to strong wind gusts.

The 6th was really the big day for the now powerful 958-mb storm, located at 45°N, 169°E. The highest wind reported was 60 kt out of the north about 120 mi west of the center, by the SEINE MARU. She also was bounced by 26-ft seas and 33-ft swells. The PRESIDENT HARRISON, near 31.2°N, 148.8°E, 950 mi southwest of the storm's center, found 60-kt winds. The CALIFORNIA, 450 mi southwest of the center at 40.6°N, 160.9°E, fared no better with measured 64-kt hurricane-force winds and 30-ft seas. Fifty-knot winds were found in all quadrants of the storm by the HOYO MARU, JAPAN POPLAR, and the MARCONAFLO MERCHANT. To the northeast and northwest of the center, the DAIKI MARU and the WAKAMIYASAN MARU were moving toward each other in a blizzard. The heavy snow was driven by 35-kt gales.

On the 7th, the LOW was the dominant weather influence over the western North Pacific. Forty-knot winds were the strongest reported, but the tightest circulation south and east of the center would indicate stronger winds. The JAPAN POPLAR, PACIFIC LOGGER, and TONAMI MARU had the dubious distinction of having these winds. On the 8th, the 952-mb LOW was at 50°N, 172°E. For over 24 hr, Ostrov Beringa had northeasterly winds of at least 50 kt. Gale-force wind reports now covered the Pacific from 30°N to 65°N and from 150°E to 165°W. Of course, there were reports of lesser winds interspersed throughout this area. The strongest wind band was off the Siberian coast, stretching southwestward from the Bering Strait to the Kuril Islands. The influx of cold air from the Bering Sea and the colder water, as the LOW moved northward, started to take its toll, and the now dual-centered storm was dying. Late on the 9th, another LOW, to the south, was moving eastward and absorbed much of the circulation. Only the secondary LOW remained to drift into Alaska.

This LOW was first discovered south of Tokyo Bay, on the 8th, as a 1011-mb depression. It did not take long for it to develop. By 0000 on the 9th, it had raced to 34°N, 160°E. A ship, which could not be identified, near 33°N, 158°E, about 100 mi from the center, and the ORIENTAL PEARL, at 29.8°N, 156.6°E, were lashed by 60-kt winds. The MAYAYSIA FORTUNE, 300 mi to the south-southwest, was heading northwestward with a 50-kt crosswind.

By 1200 on the 10th, this LOW was near 46.5°N, 179.5°E and had a pressure of 952 mb. The SEA SPIRIT and the SHINTO MARU, south and northeast of the center, respectively, rode out 50-kt gales and seas to 20 ft. The YAMAAKI MARU, at 39.6°N, 175.8°E, really had a rough time for a while. The 50-kt winds were blowing moderate rain and stirring up 21-ft seas from the southwest while 33-ft swells were rolling by from the northwest. Early on the

11th, the LOW crossed the Aleutian Islands into the Bering Sea. The JFAE and the YGUAZU, both about 400 mi south of the center, were battered by 50-kt storm winds. The Pribilof Islands were lashed by northeasterly 50-kt winds. The LOW tracked up the Aleutians and, on the 12th, crossed into Alaska and was defeated by the snow-covered mountains. The STAR ACADIA was the last ship to feel the wrath of the storm.

The area south of Japan was very prolific in spawning storms this month. A general area of depression existed on the 12th. The YGUAZU was bounced by 56-kt west winds, near 44.6°N, 177°W, as a LOW passed north of her. By the 13th, one of the LOWS had developed and moved eastward. At 1200 on the 13th, it was near 39.5°N, 150.0°E, at a 986-mb pressure. It was on the 14th that things broke loose. The MANDARIN VENTURE, east of the front, encountered 70-kt hurricane-force winds and 30-ft swells from the east-southeast. The FIGARO, about 150 mi southeast of the LOW, was tossed by 60-kt winds, with the visibility less than 1/10 mi in rain and drizzle. The TOTEN MARU, 200 mi to the south, suffered only 50-kt winds, as did the TRANSOCEAN TRANSPORT, near 44°N, 156°E, with 30-ft seas. The LOTUS reported only 25-kt winds, as the center passed almost directly over her position at 0000 on the 14th. Later that day, the JDGQ was lashed by 55-kt winds, just off Ostrov Iturup, and the VENEZUELA MARU, at 39.6°N, 156.7°E, was hammered by a 60-kt storm wind driving 16-ft seas and 26-ft swells. The 962-mb storm reached its lowest pressure near 44.5°N, 156.5°E. On the 15th, the WORLD INFLUENCE, south of Attu Island, would have liked to influence the 50-kt freezing wind she was battling. The LOW continued its north-northeastward movement, now filling as it approached the Bering Sea. Once into the Bering Sea, an almost explosive filling occurred, and by the 18th, the LOW no longer existed.

This LOW originated in the vicinity of Japan as did the others, but this time further south. As previously, the original deepening was very quick. By 1200 on the 17th, the pressure was 968 mb, a drop of 41 mb in 36 hr. At that time, the LOW was at 39.5°N, 157.7°E, and the SULEYMAN STALSKIY, 90 mi due south, could barely proceed against the 80-kt hurricane-force winds off her port bow. She reported 10-ft seas atop 40-ft swells. At 1200 on the 18th, the 968-mb LOW was at 47.5°N, 161.3°E. Three ships reported winds of 50 to 55 kt in an arc about 220 mi to the south. They were the SANTA MONICA MARU, the SEIHO MARU, and an unidentified ship that was also battered by 36-ft seas. The LOW moved up nearly the same track as its predecessors, as if in a rut. As usual, the pressure started to rise as the storm neared the Bering Sea. On the 19th, the DAISHOWA MARU, 500 mi southeast of the center, found a 50-kt wind band.

The progress of the LOW was now very slow as it approached the Near Islands, and a frontal wave raced across the ocean south of it. Early on the 21st, this new LOW completely absorbed the original one, plus a third LOW that lived only a few hours. This last one had time to swipe the PRESIDENT TAFT with 55-kt winds, 17-ft seas, and 20-ft swells.

This LOW first had an opportunity to affect shipping, on the 20th, as it moved into the Sea of Japan. This was not its start though, as it had spent many previous days tracking across the southern U.S.S.R. The storm moved rapidly across Japan and, on the 21st, was near 40.5°N, 150.0°E. The pressure was 998 mb. Thirty-six hours later, at 0000 on the 23d, the pressure was 952 mb and the center was at 45.5°N, 165.0°E. The MEISHUN MARU was only about 60 mi from the center when she reported 50-kt southerly winds. The AIKO MARU was about 300 mi south of the center, and was boosted along by 50-kt westerlies. Twelve hours later, she was getting an additional 5 kt of wind. The DAIAN MARU was rolling west as fast as the 60-kt rain storm, 20-ft seas, and 20-ft swells out of the north, would allow. The MONTIRON, at 38.2°N, 175°W, almost 1,000 mi southeast of the center, ahead of the front, proceeded cautiously with 55-kt winds and visibility near zero. Far to the north, the ARCTIC TOKYO, at 53.3°N, 172.7°E, encountered the same speed winds and visibility, only many degrees colder.

On the 24th, the LOW had curved to an easterly path. The JHHE found the same strong wind band south of the center that the other ships encountered. The swell had increased to 33 ft. Slightly farther west, the TOKUSEI MARU was battling 50-kt gales which decreased to 35 kt 12 hr later. Early on the 25th, the LOW moved across Adak Island into the Bering Sea and, within a few hours, was a mere trough after having survived the rigors of Siberia, earlier.

This was another LOW that had a continental origin, appearing in the Sea of Japan, on the 28th, at 1003 mb. It stayed on a more easterly track and made it into the Gulf of Alaska. The LOW had galloped to 38°N, 157°E, by 0000 on the 29th. Within the hour, it had passed very close to the FEDERAL MACKENZIE, which was pounded by 70-kt shifting winds. One good thing was that the speed that the LOW was moving, it would not effect any one place or ship for too long at a time. The FEDERAL MACKENZIE, which was moving in the same direction as the LOW, reported only 30-kt gales, 12 hr later. The LOW reached a pressure of about 990 mb and continued moving northeastward at about 30 kt.

The LOW was of little danger to shipping for the rest of its lifespan. On the 31st, the ELLEN BAKKE was buffeted by 45-kt gales and the HONOLULU MARU had 40-kt gales. The ELLEN BAKKE appeared to have tracked north-northeastward with the LOW. At 0000 on the 1st, she was experiencing a 40-kt southwesterly gale. On the 2d, the LOW was well into the Gulf of Alaska with a pressure of 1003 mb. On the 3d, the LOW disintegrated south of Valdez, Alaska.

As the LOWS moved into the Gulf of Alaska, a stationary HIGH was sitting about 700 mi west-southwest of San Francisco. A LOW in the desert southwest intensified, and several ships found strong winds off the California coast on the 29th. The GOLDEN GATE, with a powerful 58-kt wind and 21-ft seas, seemed to have gotten the worst of it. Other reports were in the 40- to 50-kt range.

Casualties--The 20,877-ton U.S.-registered tanker, EAGLE LEADER, arrived at Honolulu on the 5th, with alleged weather damage. The Cypriot motorship

MARINER (7,916 tons) was abandoned by the crew when she encountered rough weather at 35.0°N, 152.8°E. Twenty-nine passengers were injured when the Japanese ferry boat UWAJIMA (900 tons) collided with the 17,715-ton Liberian LILAC, in the fogbound Bungo Channel. Both ships suffered minor damage. The 7,832-ton CIRCEA and the 11,907-ton EASTGATE collided in fog in the approach to Hong Kong, on the 30th. The EASTGATE was abandoned by her crew with three crewmembers dead. The CIRCEA assisted in rescue operations.

SMOOTH LOG, APRIL 1973--Unlike the Atlantic, the Pacific storm tracks this month closely matched the climatological pattern. A primary track emerged from the U. S. S. R. across Sakhalin Island, and another originated south of Japan. The two merged southwest of Attu Island, and then the track followed the Aleutians eastward into the Gulf of Alaska. Near 180°, an offshoot went into Norton Sound. The actual storm tracks were not bunched, but followed the general pattern. Except south of Japan, very few storm centers originated or tracked south of 40°N.

When the storm tracks follow the climatic pattern, it should follow that the monthly mean pressure would also follow that pattern; and it did. There were two significant differences between the actual and the climatology pattern. The first difference was that the flat-oval Aleutian Low was broken into two distinct Lows--one centered south of Unimak Island, the other centered over Sakhalin Island. The second difference was a bubble of higher pressure at the eastern end of the Pacific High, off the California coast. The two low-pressure areas were near the climatology average of 1009 mb. The pressure of the Pacific High averaged 1 mb higher than normal, except the eastern bubble was over 4 mb higher. Again this month, the pressure near the North Pole was much above normal.

This brings us to the anomalies. The largest was near the pole. This positive 16-mb departure was located near 82°N, 160°E. A positive anomaly ridge extended from that center southward, along about 180°. This was the area that separated the two Lows. A plus 8-mb anomaly center was located off the U. S. West Coast, near 42°N, 132°W, as a result of the bubble High. The only negative anomaly in the North Pacific this month was a minus 3 mb, located south of 50°N, between 160° and 170°W.

No tropical storms occurred this month. During April, tropical storms can be expected to occur in 3 out of 4 yr in the western Pacific. In the eastern waters, none would be expected during April.

On the first day of the month, southern California was swept by high winds resulting from a LOW over the Great Basin of Nevada and Utah, and a large HIGH off the coast. Widespread damage resulted from winds of over 50 kt at some high elevations. Small-craft advisories warned of gale-force winds along the coast. A 30-ft boat was capsized by wind and swell off San Diego. Guadalupe Island reported 40-kt gales. At 0000 on the 2d, the BUDAPEST and the VICTORIA CITY encountered 35-kt gales with sea and swell up to 12 ft, off the coast between San Francisco and Punta Eugenia, Baja California.

A 1007-mb depression appeared on the 0600 chart of the 3d, just south of Shikoku, Japan. The LOW moved northeastward, and at 1200 on the 4th was near 37°N, 147.5°E, at 992 mb. The SCOTLAND MARU, north of the warm front and 150 mi east of the center, was washed by rain and 40-kt gales. As the LOW raced northeastward, off the Kuril Islands, at 40 kt, the HARIMA MARU reported 40-kt gales. The LOW crossed into the Bering Sea near Ostrov Mednzy, on the 6th, and it slowed as it took an easterly course. The pressure dropped to 977 mb on the 7th. The KIYOSHIO MARU, east of Near Island, had a 40-kt wind and 18-ft seas on her starboard side. Two island weather stations in the Aleutians reported 40- to 45-kt winds with snow showers. The EASTERN BUILDER, near 43.6°N, 174.8°E at 1800, reported 45-kt winds well south of the LOW.

On the 8th, two ships, the HARIMA MARU and the HONSHU MARU, were buffeted by 40-kt gales south of the center. The DERWENTFIELD reported 50-kt winds at 1800 on the 8th, and 55-kt winds at 0000 on the 9th. near 54°N, 178°E. Waves were 23 ft at the later time. The LOW moved into Bristol Bay on the 9th, and took its most severe swing at shipping. The JUNEAU MARU, at 55.5°N, 179.5°W, was rolled by 60-kt winds and 20-ft swells from the northwest. Twelve hours later in the same area, the HAWAII was headed north with snow driven by 40-kt gales and 20-ft seas. On the 10th, the storm stalled over Unimak Island, and, on the 11th, was absorbed by a LOW moving east along the Aleutians.

<u>Monster of the Month</u>--This LOW was born at sea, on a cold front that extended from Vancouver Island to just north of the Hawaiian Island chain, on the 3d. On the 4th, an elongated circulation had developed, and the CHIKUGO MARU, the HAWAIIAN MOTORIST, and the SADOHARU MARU encountered 35-kt gales, with seas to 15 ft and swells to 20 ft, on the north side of the front. At 2000 the OREGON made a special observation, indicating 60-kt winds from the north and 25-ft swells, near 35.5°N, 154°W. At 0000 on the 5th, the HAWAIIAN MOTORIST was pounded by 60-kt winds and 36-ft swells, near 35.5°N, 154.5°W. Four hundred plus miles to the northeast, the PRESIDENT HAYES was riding out 40-kt winds, with sea and swell both up to 23 ft. Three hundred miles west of the center, which at that time was near 33.3°N, 151°W, the DELWIND reported 45-kt gales and 33-ft seas.

The LOW was now moving slowly northward, as the circulation increased and became more circular. At 0000 on the 6th, the GUAM BEAR hit 45-kt gales 200 mi south of the center. To the west a ship reported 26-ft swells. The LOW was filling as it picked up speed in its northerly movement to the Gulf of Alaska. On the 8th, the system was no longer identifiable.

This LOW developed at the point of occlusion, as the frontal system moved over the Kuril Islands. The system deepened, and by 0000 on the 10th, had a pressure of 984 mb, near 50°N, 166°E. The AMERICAN WHEAT and the KIYOSHIO MARU had southerly 40-kt gales ahead of the LOW and front. Ostrov Paramushir, southwest of the center, battened down with 50-kt winds. The LOW turned to an easterly track, south of the Aleutian Islands, for the next 36 hr. Three ships reported 40-kt gales, as the LOW passed north of them. On the 12th, the storm divided into two LOWS,

one south and one north of the Aleutians. Late on the 12th, the new development became the primary system and continued to move northward into Norton Sound.

A 1007-mb LOW departed from the Port of Shanghai at 0000 on the 11th. After a port call across Japan, it took the long sea voyage to British Columbia. The initial part of the voyage was very smooth and fast, with no high winds or rough seas. Within 24 hr it had called at and departed from the length of Japan. The storm's "draft" had changed only slightly, to 995 mb, at 1200 on the 12th, when it was near 42.3°N, 154°E. The LOW was moving with the Kuroshio current and started to intensify. Several ships south of the center reported gale-force winds. Two ships traveling eastward with the LOW, the JAPAN ELM and the RHEIN MARU, had 40- to 45-kt gale winds for over 12 hr, as the LOW overtook and passed them. At 1200 on the 13th, the storm reached its lowest pressure of 972 mb. The VAN ENTERPRISE found 48-kt northeasterly winds, 200 mi north of the storm's center.

The LOW, on its great circle course, was about 2° latitude south of the Aleutians on the 14th and 15th, and the BROOKLYN was hit by 50-kt storm winds well ahead of the LOW, near 54.7°N, 137.5°W. On the 16th, it was in the Gulf of Alaska. At 1200 on the 16th, it was at 55.5°N, 140.6°W, and Ocean Station Vessel "P" measured 40-kt gales. At 1200 on the 17th, the LOW passed into Dixon Entrance and foundered on the rocky coast near Prince Rupert, B. C.

A slight ripple was evident on a front in the East China Sea, at 0000 on the 21st. Twenty-four hours later it had developed into a 1000-mb LOW northeast of Tokyo. By 1200 on the 22d, gale-force winds were blowing in the eastern half of the storm, as the HOEGH MARLIN could attest. At 1200 on the 23d, the LOW's center was at 43.5°N, 160.2°E, and the SITKA MARU, 100 mi to the east, was washed by heavy rain driven by 45-kt winds. Another LOW, which had come out of Manchuria and across the Tatar Strait early on the 23d, combined forces on the 24th, as the original LOW executed a cyclonic loop. As the two LOWS approached each other, the MIDAS RHEIN was caught by powerful 70-kt winds and 30-ft seas. Eighteen hours later, she was still battling freezing 50-kt gales. The EASTERN BUILDER, at 41.5°N, 153.5°E, was pounded by 45-kt gales and 23-ft swells. The FERNLEAF, which was at 40.5°N, 157.3°E, was headed into 55-kt storm winds and 15-ft seas, with 25-ft swells quartering off the port side.

By 0000 on the 25th, the LOW completed its loop and was again headed eastward, stronger than ever. The FEDERAL MACKENZIE, 270 mi southeast of the center, found 50-kt winds. Four other ships in the western half reported 35- to 40-kt gales. Sea and swell were running 15 to 20 ft. Gale winds continued in all quadrants for the next 24 hr, and the SENDAN MARU, 200 mi north of the center at 0000 on the 26th, was lashed by 45-kt gales off her stern. The storm was moving northeastward along the tracks followed by several previous storms. The OTRAD NOE, on the western edge of the storm, came through with 40-kt gales.

On the 29th, the LOW split into three distinct centers, and the southernmost LOW became the dominant circulation center by the 30th.

<u>Casualties</u>--On the 4th, the PHILIPPINE PRESIDENT GARCIA (9,938 tons) reported heavy weather damage. Two people were rescued by a Coast Guard helicopter after an 8-ft wave washed them overboard from the 30-ft sailboat MEERSCHAUM. The Greek motor vessel MIHALIOS XILAS (12,662 tons), Yokohama to Portland, Oreg., arrived at Portland with alleged heavy weather damage on the 10th. On the 26th, dense fog blanketed much of Honshu. There were five collisions involving ten ships in the Inland Sea. The 990-ton tanker MATSU MARU and 1,400-ton freighter No. 25 GION MARU collided near Tokuyama Port. Seven crewmen died when the tanker burst into flames. The Japanese motorship SURABAYA MARU (7,072 tons) and the Somali motorship MINGLAND (8,515 tons) were heavily damaged in a collision in the fog 3 mi southwest of Kobe.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

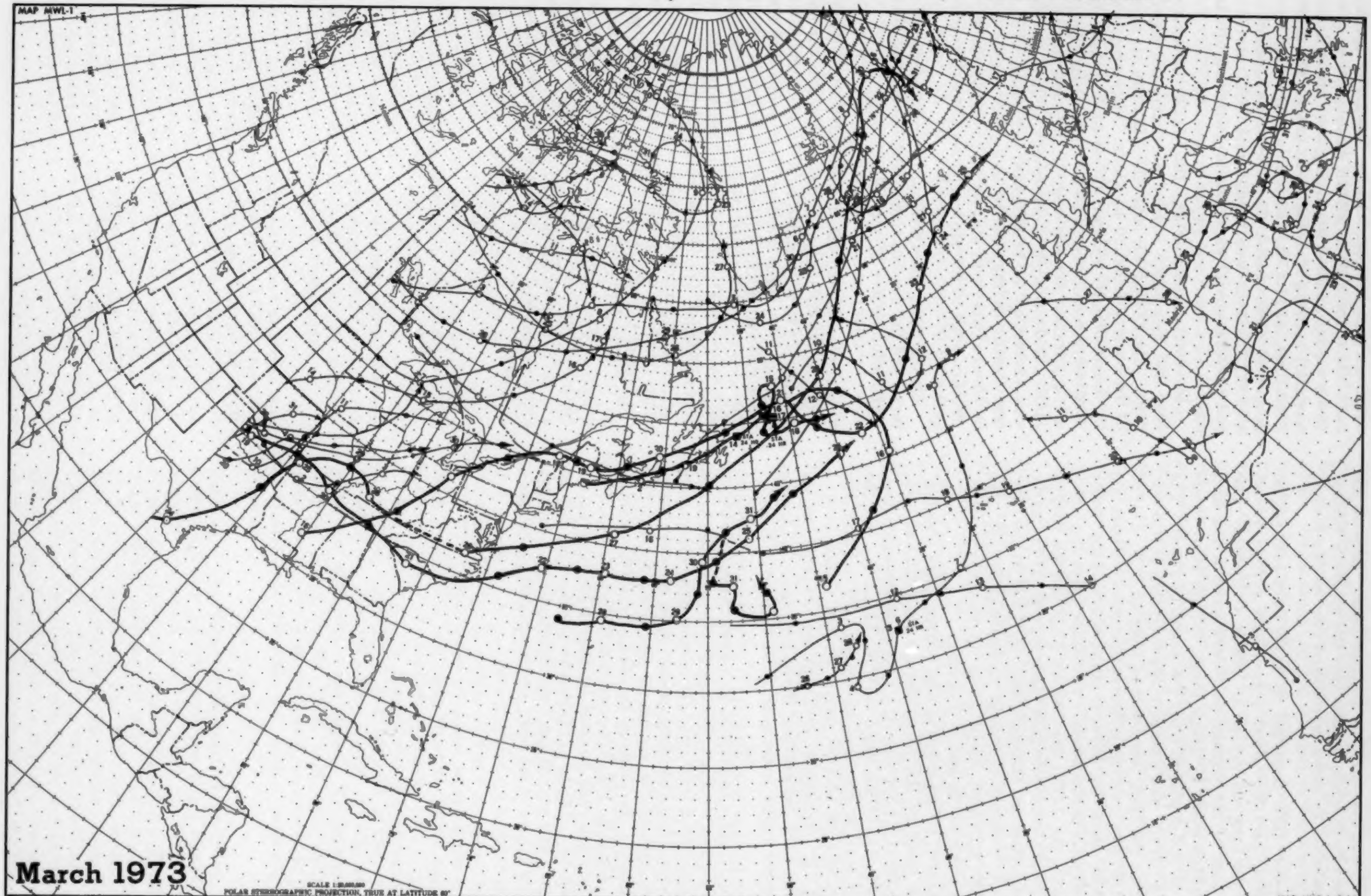

Figure 29.-- Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

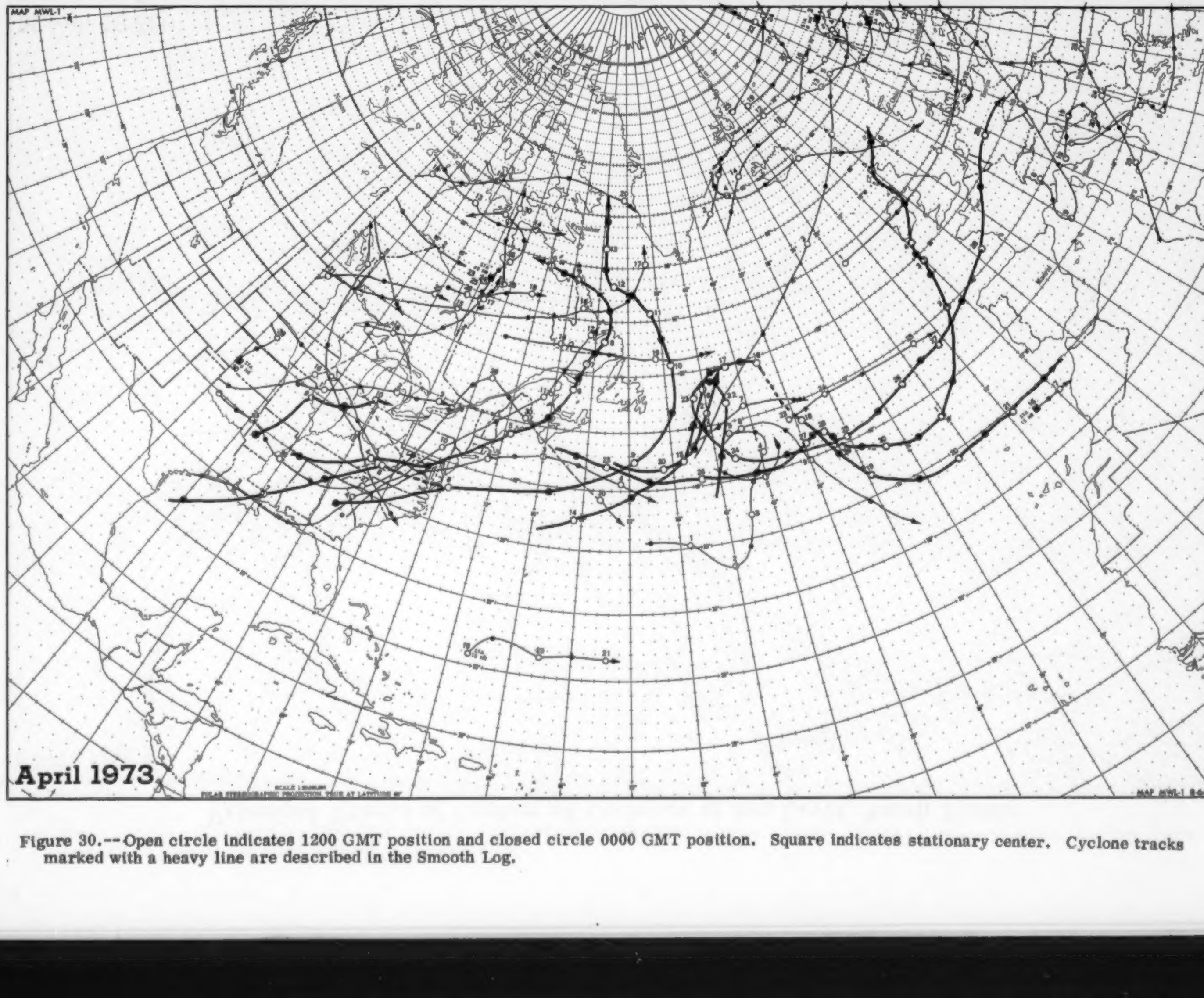

Figure 30.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

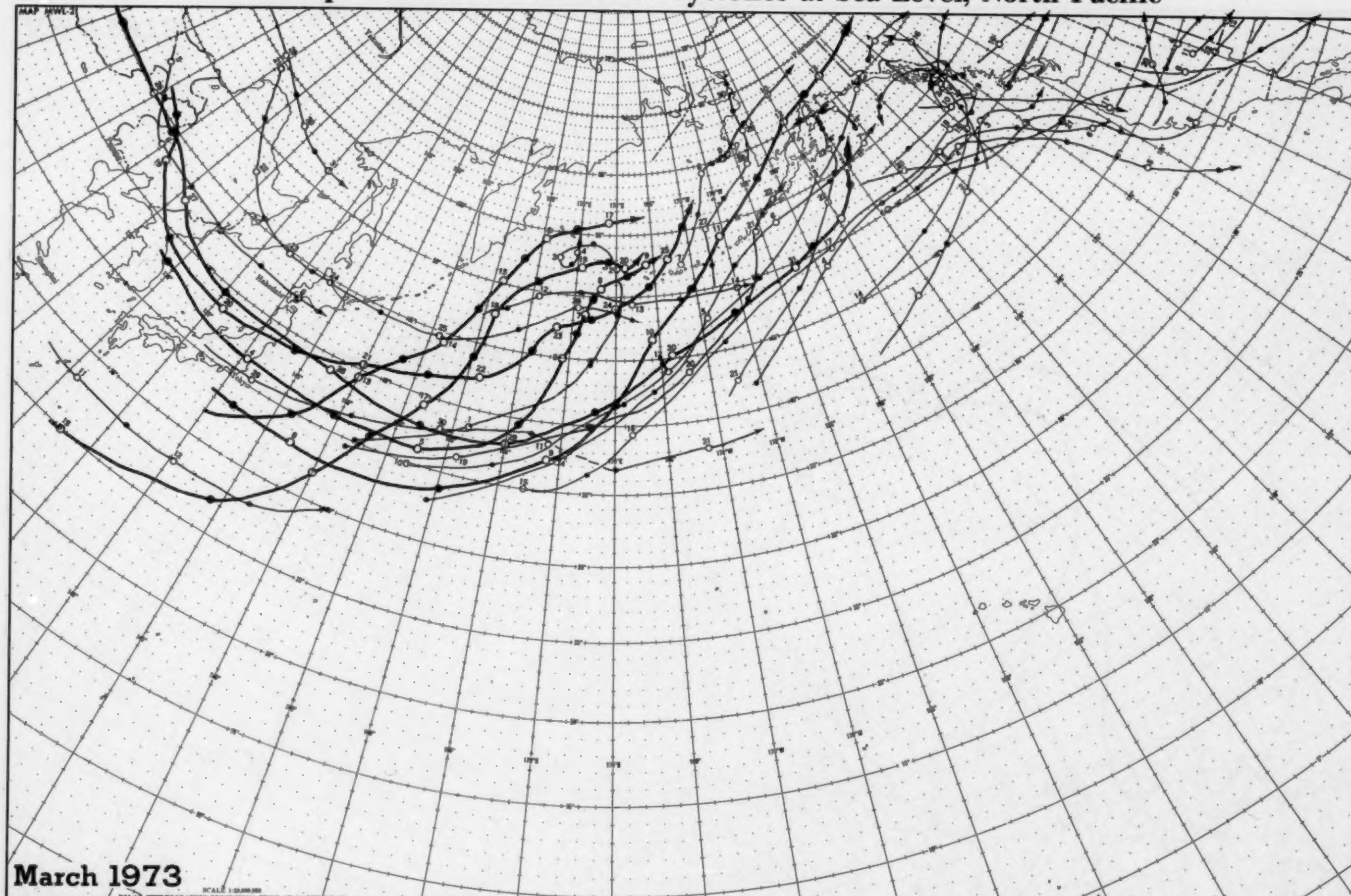

Figure 31.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

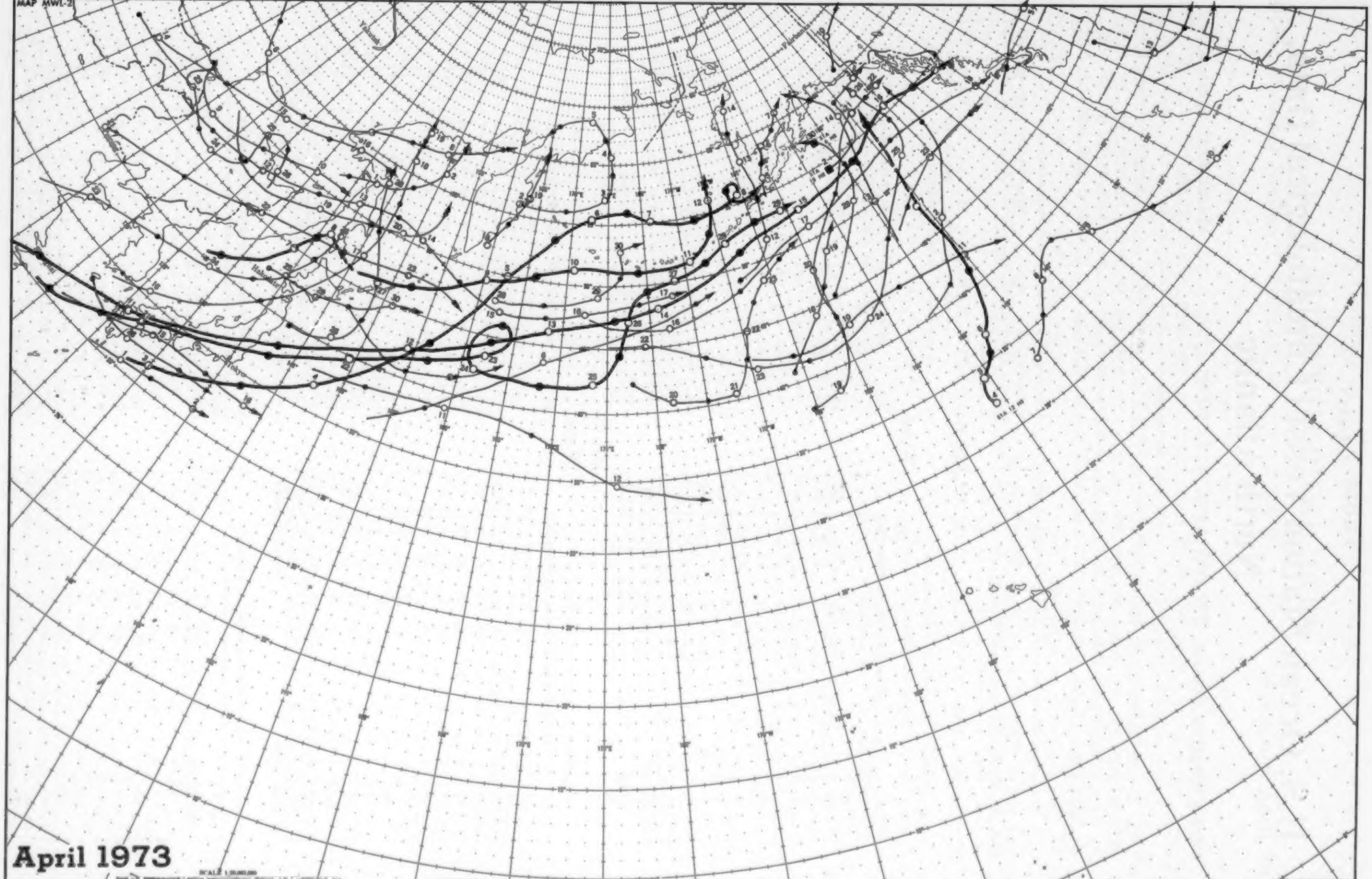

Figure 32.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 7

U.S. Ocean Station Vessel Climatological Data, North Atlantic

Ocean Weather Station 'BRAVO' 56°30'N 51°00'W **March and April, 1973**

MEANS AND EXTREMES

	DRY BULB TEMP (°C)					DEW-POINT TEMP (°C)					SEA TEMP (°C)					AIR-SEA TEMP DIFFERENCE (°C)				
MONTH	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR
MAR	- 9.2	28 06	- 1.7	4.5	20 00	-14.8	02 12	- 3.1	3.4	20 00	1.1	*17 09	2.9	4.7	*17 03	-11.9	*28 06	- 4.7	2.3	17 09
APR	- 4.9	03 21	1.8	5.8	07 12	-11.7	04 00	- 1.0	4.9	07 18	2.2	*07 09	3.4	5.6	09 18	- 7.9	03 21	- 1.5	2.8	07 09

	MEANS AND EXTREMES: PRESSURE (MB)					PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD				LOW CLOUD				DAYS WITH SPECIFIED WEATHER										
MONTH	MIN	DA HR	MEAN	MAX	DA HR	0-2	3-5	6-7	8 & OBSC	0-2	3-5	6-7	8 & OBSC	PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
MAR	993.1	27 00	1007.9	1029.6	31 12	.5	5.5	36.7	57.3	2.0	13.6	35.2	49.2	23	23	19	0	7	12	0	0	24	44.7	199
APR	988.0	12 09	1016.4	1037.5	28 21	3.8	7.9	20.0	68.3	9.2	15.4	23.3	52.1	25	23	16	0	6	4	0	0	30	28.3	240

** VV-90-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

MAR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.0	.9	7.4	3.6	.0	11.9	31.8
NE	.0	.1	1.1	1.8	.9	.0	3.9	26.9
E	.0	6.9	3.5	.4	.0	.0	10.8	10.6
SE	.0	.0	.9	.5	.0	.0	.5	24.0
S	.8	1.0	2.6	1.4	.0	.0	5.8	16.5
SW	.3	.1	4.6	3.0	.0	.0	7.8	20.1
W	.0	.9	6.5	15.5	.8	.0	23.6	23.3
NW	.0	2.5	9.5	13.8	9.8	.0	35.7	25.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.0	11.6	28.6	43.7	15.1	.0	100.0	23.2

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR
199	270	45	*25 0200	14.7	307

(DIR IN DEGREES)

APR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.3	.8	2.7	4.3	2.0	.0	9.9	23.0
NE	.0	2.7	3.8	4.3	.1	.0	11.0	18.5
E	.0	2.0	8.8	5.3	1.8	.0	17.8	19.2
SE	.0	1.4	9.7	7.1	.7	.0	18.9	20.9
S	.0	.7	3.9	5.3	.3	.0	10.2	20.7
SW	.4	3.2	5.2	4.9	.1	.0	13.9	16.3
W	.8	3.4	2.5	1.6	.0	.0	8.3	12.4
NW	.1	2.6	6.0	.0	.0	.0	8.8	11.6
CALM	1.3	.0	.0	.0	.0	.0	1.3	.0
TOTAL	2.9	16.7	42.5	32.9	5.0	.0	100.0	18.2

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR
240	360	40	22 1800	5.1	114

(DIR IN DEGREES)

Wave

MAR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	2.0	5.0	3.8	9.7	2.8	.0	.0	23.2
NE	.0	.0	5.0	4.1	.8	.3	.0	.0	10.2
E	1.5	1.0	2.0	.0	.0	.0	.0	.0	4.5
SE	.0	.0	.0	.0	.0	.0	.0	.0	.0
S	.0	1.3	.0	.5	.4	.0	.0	.0	2.1
SW	.0	2.1	3.8	1.8	.6	.0	.0	.0	8.3
W	.0	2.4	7.9	7.5	4.8	.0	.0	.0	22.6
NW	.0	5.3	5.4	3.9	11.9	2.5	.0	.0	29.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.5	14.1	29.1	21.6	28.1	5.3	.0	.0	100.0

NUMBER OF OBS 199 IND=INDETERMINATE

APR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	3.5	1.4	3.4	3.0	.0	.0	.0	11.4
NE	.0	1.9	4.3	2.9	1.1	.0	.0	.0	10.4
E	.0	6.4	7.7	2.0	4.3	.0	.0	.0	20.3
SE	.0	5.0	8.5	10.4	4.1	.0	.0	.0	28.0
S	.0	1.4	1.3	2.2	.0	.0	.0	.0	4.8
SW	.4	2.3	3.0	3.2	.4	.0	.0	.0	9.4
W	.0	1.9	1.1	.8	.0	.0	.0	.0	3.9
NW	.0	6.0	.0	.0	.0	.0	.0	.0	6.0
IND	.0	4.2	1.7	.0	.0	.0	.0	.0	5.8
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.4	32.5	29.2	25.0	12.9	.0	.0	.0	100.0

NUMBER OF OBS 240 IND=INDETERMINATE

MAR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	1.5	8.0	1.5	1.0	.0	.0	.0	.0	12.1
6-7	.0	5.0	22.6	11.1	6.5	.0	.0	.0	45.2
8-9	.0	1.0	5.0	9.5	19.1	5.0	.0	.0	39.7
10-11	.0	.0	.0	.0	2.5	.5	.0	.0	3.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.5	14.1	29.1	21.6	28.1	5.5	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
199	6.5	9	300	SEA	03 09

IND=INDETERMINATE (DIR IN DEGREES)

APR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.4	14.6	1.7	1.3	.0	.0	.0	.0	17.9
6-7	.0	6.7	10.4	11.7	5.4	.0	.0	.0	34.2
8-9	.0	6.3	12.1	8.3	7.5	.0	.0	.0	34.2
10-11	.0	.8	2.9	3.3	.0	.0	.0	.0	7.1
12-13	.0	.0	.4	.4	.0	.0	.0	.0	.8
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	4.2	1.7	.0	.0	.0	.0	.0	5.8
TOTAL	.4	32.5	29.2	25.0	12.9	.0	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
240	5.5	8	110	SEA	07 18

IND=INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

Table 8
CLIMATOLOGICAL DATA

Ocean Weather Station 'CHARLIE' 52°45'N 35°30'W — March and April, 1973

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
MAR	- 2.8	03 12	4.6	8.8	01 12	-11.8	03 18	1.8	7.9	*16 15	3.3	*16 15	5.3	10.0	*13 03	- 6.7	03 12	- .7	4.6	16 13
APR	1.3	04 06	6.9	11.2	25 15	- 5.0	01 21	4.7	8.0	*20 15	3.3	04 00	6.5	10.3	25 12	- 5.8	02 15	.5	3.8	08 18

MONTH	MEANS AND EXTREMES: PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER: PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OB.
MAR	986.5	01 15	1007.6	1028.0	30 00	5.6	10.8	22.1	61.5	13.3	18.9	28.6	39.3	21	20	9	0	9	10	0	0	24	23.5	196
APR	999.8	03 03	1020.0	1030.6	15 12	5.9	7.2	24.9	62.0	15.6	15.2	22.4	46.8	21	20	1	0	8	7	0	0	29	19.2	237

** VV-90-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

MAR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	1.3	2.7	.0	.5	.0	4.5	15.9
NE	.0	1.0	1.3	.0	.0	.0	2.3	10.8
E	.0	.9	6.3	3.3	.9	.0	11.4	18.3
SE	.0	1.8	10.8	5.4	.8	.0	18.6	19.5
S	.0	.9	3.2	3.3	.4	.0	7.8	20.1
SW	.0	2.2	9.6	7.3	.6	.0	19.6	20.9
W	.0	.4	6.5	12.2	5.0	.0	24.1	27.3
NW	.0	1.3	3.6	5.7	1.1	.0	11.7	22.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	9.7	43.9	37.2	9.2	.0	100.0	21.4

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
195	200	47	01 1200	7.9	238	

APR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.7	2.7	1.6	.4	.0	5.5	19.9
NE	.0	2.2	10.1	5.1	1.3	.0	18.7	17.8
E	.0	.3	9.4	9.3	2.7	.0	21.7	23.7
SE	.0	.7	13.9	20.6	1.9	.0	37.1	23.1
S	.0	1.1	5.7	2.7	.0	.0	9.5	18.5
SW	.4	.5	.0	.0	.0	.0	.9	4.4
W	.0	1.2	1.6	.0	.0	.0	2.7	12.5
NW	.0	.0	3.4	.0	.0	.0	3.4	15.5
CALM	.4	.0	.0	.0	.0	.0	.4	.0
TOTAL	.8	6.8	46.8	39.2	6.3	.0	100.0	20.9

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
237	100	42	08 0300	14.1	108	

Wave

MAR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	.0	.9	.0	.5	.0	.0	.0	1.4
NE	.0	.0	.0	.0	.0	.0	.0	.0	.0
E	.0	1.4	4.1	4.6	2.2	.0	.0	.0	12.2
SE	.0	2.8	7.1	4.6	4.0	.1	.0	.0	18.6
S	.0	.9	1.5	2.3	3.3	1.9	.0	.0	9.9
SW	.0	.0	7.7	4.8	5.1	.0	.0	.0	17.6
W	.0	.0	5.7	.5	18.6	.0	.0	.0	24.9
NW	.0	.0	5.1	1.0	4.6	1.5	.0	.0	12.2
IND	.0	.0	.0	1.0	2.0	.0	.0	.0	3.1
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	5.1	32.1	18.9	40.3	3.6	.0	.0	100.0

NUMBER OF OBS 196 IND=INDETERMINATE

APR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	.7	2.2	2.3	.0	.0	.0	.0	5.3
NE	.0	7.5	2.2	4.1	1.4	.8	.0	.0	16.1
E	.0	3.0	7.1	3.9	3.8	.0	.0	.0	17.8
SE	.4	15.1	12.4	5.8	2.4	.0	.0	.0	36.2
S	.0	2.0	7.6	.3	.0	.0	.0	.0	10.0
SW	.0	.8	.4	.0	.0	.0	.0	.0	1.3
W	.0	.3	.4	.0	.0	.0	.0	.0	.7
NW	.0	.5	6.5	.4	.0	.0	.0	.0	7.5
IND	.0	3.0	2.1	.0	.0	.0	.0	.0	5.1
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.4	33.1	41.1	16.9	7.6	.8	.0	.0	100.0

NUMBER OF OBS 236 IND=INDETERMINATE

MAR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	5.1	18.4	4.6	.0	.0	.0	.0	28.1
6-7	.0	.0	7.7	7.1	7.7	.0	.0	.0	22.4
8-9	.0	.0	6.1	6.1	29.6	1.5	.0	.0	43.4
10-11	.0	.0	.0	.0	1.0	.0	.0	.0	1.0
12-13	.0	.0	.0	.0	.0	2.0	.0	.0	2.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	1.0	2.0	.0	.0	.0	3.1
TOTAL	.0	5.1	32.1	18.9	40.3	3.6	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
196	6.0	12	180	SWL	01 15

IND=INDETERMINATE (DIR IN DEGREES)

APR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.4	24.6	7.2	.0	.0	.0	.0	.0	32.2
6-7	.0	3.0	19.5	7.6	1.7	.8	.0	.0	32.6
8-9	.0	2.5	8.5	8.9	5.9	.0	.0	.0	25.8
10-11	.0	.0	2.5	.0	.0	.0	.0	.0	2.5
12-13	.0	.0	.8	.4	.0	.0	.0	.0	1.3
>13	.0	.0	.4	.0	.0	.0	.0	.0	.4
IND	.0	3.0	2.1	.0	.0	.0	.0	.0	5.1
TOTAL	.4	33.1	41.1	16.9	7.6	.8	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
236	6.5	7	080	SEA	03 00

IND=INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATION?

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 9
CLIMATOLOGICAL DATA

Ocean Weather Station 'DELTA' 44°00'N 41°00'W — March and April, 1973

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
MAR	2.5	11 15	10.3	17.0	20 21	- 3.2	11 15	6.4	14.8	*31 06	11.0	*14 09	14.3	16.3	*17 21	-12.1	07 15	- 4.0	4.5	14 06
APR	6.2	*23 06	12.4	16.3	02 09	.3	23 03	9.6	14.7	02 00	13.0	21 03	14.4	16.1	26 09	- 7.9	10 21	- 2.0	1.9	02 09

MONTH	MEANS AND EXTREMES: PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER: PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
MAR	993.0	14 06	1012.3	1032.6	03 03	1.4	11.4	38.2	49.1	11.4	25.5	30.9	32.3	24	24	4	0	3	12	4	0	26	26.8	220
APR	983.3	22 09	1006.2	1022.2	11 15	3.2	7.9	24.3	64.6	10.6	21.2	23.8	44.4	22	22	0	1	3	8	1	0	19	25.9	189

** VV=90-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

MAR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.5	3.0	3.5	.5	.0	7.4	22.0
NE	.5	.1	.0	2.4	.0	.0	3.0	23.7
E	.0	.3	1.4	3.0	.0	.0	4.7	20.1
SE	.5	.6	3.5	.7	.9	.0	6.1	19.0
S	.0	1.1	7.7	5.6	.7	.9	16.0	22.6
SW	.0	1.5	5.1	5.5	1.6	.0	13.6	22.2
W	.0	.3	3.4	7.6	2.0	.3	13.6	26.1
NW	.0	1.0	9.5	18.2	6.6	.1	35.5	25.6
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.9	5.3	33.6	46.4	12.3	1.4	100.0	23.7

NUMBER OF OBS 220 — MAX WIND: DIR 290, SPEED 55, DA HR 22 1215 — VECTOR SPEED 10.5, MEAN DIR 281 (DIR IN DEGREES)

APR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.5	4.1	5.3	.0	.0	9.9	20.7
NE	.0	.1	4.0	3.0	.0	.0	7.1	20.9
E	.0	8.6	6.0	1.5	.0	.0	16.0	11.3
SE	.5	6.9	3.3	4.9	1.7	.0	17.3	17.2
S	.0	4.0	5.3	7.0	1.5	.0	17.7	19.9
SW	.0	.1	5.3	3.2	.7	.0	9.3	21.8
W	.0	2.2	2.6	2.8	2.0	.0	9.7	20.6
NW	.0	2.4	3.3	6.2	.0	.0	11.9	19.5
CALM	1.1	.0	.0	.0	.0	.0	1.1	.0
TOTAL	1.6	24.9	33.9	33.9	5.8	.0	100.0	18.3

NUMBER OF OBS 189 — MAX WIND: DIR 140, SPEED 48, DA HR 10 0755 — VECTOR SPEED 2.6, MEAN DIR 190 (DIR IN DEGREES)

Wave

MAR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	1.9	3.5	1.6	.5	.0	.0	.0	7.5
NE	.0	.6	1.1	.6	1.8	.0	.0	.0	4.1
E	.0	.0	.0	3.1	.0	.0	.0	.0	3.1
SE	.0	2.6	.5	.9	.6	.0	.0	.0	4.5
S	.0	4.4	4.3	2.3	1.6	.0	.0	.0	12.6
SW	.0	.7	9.3	3.4	2.4	.0	.0	.0	15.8
W	.0	.0	6.5	9.3	2.8	.0	.0	.0	18.6
NW	.0	3.4	9.8	8.0	8.1	.0	.0	.0	29.2
IND	.0	.9	3.2	.5	.0	.0	.0	.0	4.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	14.5	38.2	29.5	17.7	.0	.0	.0	100.0

NUMBER OF OBS 220 IND=INDETERMINATE

APR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	.0	2.5	2.9	.5	.9	.0	.0	6.9
NE	.0	2.7	6.5	7.3	2.0	.1	.0	.0	18.6
E	.0	1.1	3.6	2.3	1.2	.0	.0	.0	8.1
SE	.5	2.4	4.8	1.6	2.8	.0	.0	.0	12.1
S	.0	1.9	7.3	6.0	2.8	.0	.0	.0	18.0
SW	.0	.5	2.3	4.4	2.8	1.1	.0	.0	11.3
W	.0	.8	3.6	.9	4.3	.5	.0	.0	10.1
NW	.0	1.9	2.7	1.2	3.3	1.1	.0	.0	10.1
IND	.0	.0	3.7	1.1	.0	.0	.0	.0	4.8
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.5	11.2	37.2	27.7	19.7	3.7	.0	.0	100.0

NUMBER OF OBS 188 IND=INDETERMINATE

MAR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	8.2	6.8	1.4	.0	.0	.0	.0	16.4
6-7	.0	4.5	16.4	17.7	13.2	.0	.0	.0	51.8
8-9	.0	.9	11.8	10.0	4.1	.0	.0	.0	26.8
10-11	.0	.0	.0	.0	.5	.0	.0	.0	.5
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.9	3.2	.5	.0	.0	.0	.0	4.5
TOTAL	.0	14.5	38.2	29.5	17.7	.0	.0	.0	100.0

NUMBER OF OBS 220 — MAX WAVE HEIGHT: HGT 5.5, PER 7, DIR 190, TYPE SEA, DA HR 01 12 — IND=INDETERMINATE (DIR IN DEGREES)

APR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.5	3.2	4.8	1.6	.0	.0	.0	.0	10.1
6-7	.0	5.3	14.9	16.3	3.2	1.1	.0	.0	41.0
8-9	.0	2.7	12.8	8.5	13.8	1.1	.0	.0	38.8
10-11	.0	.0	1.1	.0	2.7	1.6	.0	.0	5.3
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	3.7	1.1	.0	.0	.0	.0	4.8
TOTAL	.5	11.2	37.2	27.7	19.7	3.7	.0	.0	100.0

NUMBER OF OBS 188 — MAX WAVE HEIGHT: HGT 6.5, PER 10, DIR 260, TYPE SEA, DA HR 17 12 — IND=INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

Table 10
CLIMATOLOGICAL DATA

Ocean Weather Station 'ECHO' 35°00'N 48°00'W **March and April, 1973**

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
MAR	11.2	12 03	17.0	21.0	25 18	2.8	*08 21	12.8	18.7	23 12	16.7	*18 12	18.6	20.4	25 18	- 7.1	12 03	- 1.6	1.9	31 15
APR	11.3	22 15	17.7	20.2	01 18	4.1	22 21	13.4	18.7	06 15	18.0	11 18	18.7	20.8	06 00	- 7.1	22 15	- 1.0	1.8	01 18

MONTH	MEANS AND EXTREMES: PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER: PCPN	RAIN OR DRZL	SNOW	TSTM	TSBY <5KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
MAR	1005.3	15 12	1018.0	1034.5	08 15	14.8	18.9	33.7	32.5	32.9	29.2	31.7	6.2	19	19	0	0	1	3	0	0	28	16.5	243
APR	1001.6	06 21	1013.6	1025.7	19 00	18.4	28.6	31.1	21.8	48.1	28.2	18.4	5.3	25	23	0	1	1	4	0	0	29	18.2	206

** VV=00-03 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

MAR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	3.6	13.0	1.3	.0	.0	17.9	14.5
NE	.0	.4	12.7	3.9	.0	.0	17.0	17.0
E	.0	.0	.7	.0	.0	.0	.7	19.1
SE	.0	.8	1.1	3.0	.0	.0	4.9	20.4
S	.4	3.1	4.3	7.7	.0	.0	15.5	18.9
SW	.0	2.4	8.1	7.8	.0	.0	18.3	18.7
W	.0	2.9	8.2	1.6	.0	.0	12.8	15.9
NW	.0	.8	7.4	2.6	.0	.0	10.8	17.4
CALM	2.1	.0	.0	.0	.0	.0	2.1	.0
TOTAL	2.5	14.0	55.6	28.0	.0	.0	100.0	17.2

NUMBER OF OBS 243; MAX WIND: DIR 270, SPEED 35, DA HR *17 0750; VECTOR SPEED 3.0; MEAN DIR 273 (DIR IN DEGREES)

APR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	1.0	1.2	2.9	.0	.0	.0	5.1	11.9
NE	1.0	.3	.5	.0	.0	.0	1.9	6.3
E	.0	.0	.0	.0	.0	.0	.0	.0
SE	2.5	2.2	2.2	.0	.0	.0	6.9	7.4
S	.7	1.2	6.4	2.3	.0	.0	10.7	17.0
SW	.1	2.1	5.8	3.9	.1	.0	12.0	18.6
W	.6	4.9	6.6	16.7	.8	.0	29.2	20.4
NW	.1	6.4	15.5	7.6	1.0	.0	30.7	18.2
CALM	3.4	.0	.0	.0	.0	.0	3.4	.0
TOTAL	9.2	18.4	39.8	30.6	1.9	.0	100.0	16.9

NUMBER OF OBS 206; MAX WIND: DIR 250, SPEED 45, DA HR 05 0200; VECTOR SPEED 11.5; MEAN DIR 273 (DIR IN DEGREES)

Wave

MAR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	6.3	5.8	1.6	.0	.0	.0	.0	13.7
NE	.0	2.8	5.8	4.5	.0	.0	.0	.0	13.1
E	.0	.0	1.2	1.2	.0	.0	.0	.0	2.5
SE	.8	4.0	3.0	.0	.0	.0	.0	.0	7.8
S	1.6	3.2	3.8	4.6	.0	.0	.0	.0	13.3
SW	.0	5.1	3.3	2.9	.0	.0	.0	.0	11.3
W	.0	9.0	3.9	5.1	.0	.0	.0	.0	18.0
NW	.0	3.0	3.3	4.6	.0	.0	.0	.0	10.9
IND	.0	3.3	6.2	.0	.0	.0	.0	.0	9.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	2.5	36.6	36.2	24.7	.0	.0	.0	.0	100.0

NUMBER OF OBS 243 IND=INDETERMINATE

APR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	1.3	1.8	.0	.0	.0	.0	.0	3.3
NE	.0	.0	1.0	.0	.0	.0	.0	.0	1.0
E	.0	2.9	.0	.0	.0	.0	.0	.0	2.9
SE	.0	3.0	.0	.0	.0	.0	.0	.0	3.0
S	.5	5.1	2.4	.0	.0	.0	.0	.0	8.0
SW	.5	5.5	4.2	.6	.0	.0	.0	.0	10.8
W	.0	3.8	16.7	4.2	1.8	.0	.0	.0	26.6
NW	.0	8.4	7.3	16.0	6.4	.0	.0	.0	38.1
IND	.0	4.4	1.0	1.0	.0	.0	.0	.0	6.3
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.0	34.5	34.5	21.8	8.3	.0	.0	.0	100.0

NUMBER OF OBS 206 IND=INDETERMINATE

MAR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	1.6	21.8	7.0	.0	.0	.0	.0	.0	30.5
6-7	.8	11.1	18.1	16.9	.0	.0	.0	.0	46.9
8-9	.0	.4	4.9	6.6	.0	.0	.0	.0	11.9
10-11	.0	.0	.0	1.2	.0	.0	.0	.0	1.2
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	3.3	6.2	.0	.0	.0	.0	.0	9.5
TOTAL	2.5	36.6	36.2	24.7	.0	.0	.0	.0	100.0

NUMBER OF OBS 243; MAX WAVE HEIGHT: HGT 3.5, PER 8, DIR 030, TYPE SEA, DA HR 03 18; IND=INDETERMINATE (DIR IN DEGREES)

APR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	1.0	11.7	2.4	.0	.0	.0	.0	.0	15.0
6-7	.0	16.5	23.8	3.9	.0	.0	.0	.0	44.2
8-9	.0	1.9	5.3	14.6	4.4	.0	.0	.0	26.2
10-11	.0	.0	1.9	2.4	3.9	.0	.0	.0	8.3
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	4.4	1.0	1.0	.0	.0	.0	.0	6.3
TOTAL	1.0	34.5	34.5	21.8	8.3	.0	.0	.0	100.0

NUMBER OF OBS 206; MAX WAVE HEIGHT: HGT 5.9, PER 10, DIR 310, TYPE SEA, DA HR 22 21; IND=INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

Table 11
Selected Gale Observations, North Atlantic
March and April 1973

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec	Sea Waves* Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH ATLANTIC OCEAN		MAR.															
SS AMER ACE	AMERICAN	1	44.6 N	37.0 W	18	19	50	5 NM	02	1011.2	13.9	12.2	7	11.5	19	9	19.5
MV CARCHESTER	LIBERIAN	1	46.1 N	33.1 W	00	22	50	5 NM	03	1018.0	13.0	11.0	8	19.5			
MV MOSENGEN	NORWEGIAN	14	38.2 N	52.3 W	18	28	M 41	10 NM	80	1005.0	17.0	20.0					
SS BALTIMORE TRADER	AMERICAN	18	39.8 N	69.7 W	18	26	55	2 NM	07	988.1	5.5	9.0	9	19.5			
MV GOWAN BANK	BRITISH	18	36.9 N	70.7 W	18	27	45	5 NM	81	994.0	14.4	22.8	6	19.5	25	>13	29.5
SS ESSO PUERTO RICO	PANAMANIAN	18	38.2 N	73.5 W	06	24	M 50	5 NM	02	989.5	7.8	6.2	9	14.5			
SS ESSO WASHINGTON	AMERICAN	18	39.2 N	72.4 W	12	27	44	10 NM	02	999.0	6.5	5.0					
SS MOBIL POWER	AMERICAN	18	37.8 N	74.3 W	12	26	45	10 NM	03	999.7	4.4	10.0	6	10			
SS BALTIMORE TRADER	AMERICAN	19	38.1 N	70.9 W	06	29	55	5 NM	02	997.3	5.5	14.0	9	19.5	25	X	24.5
MV GOWAN BANK	BRITISH	19	37.5 N	72.0 W	00	29	45	5 NM	81	995.5	11.7	23.3	6	18	27	>13	28
SS ESSO PUERTO RICO	PANAMANIAN	19	35.4 N	74.3 W	00	27	M 50	10 NM	02	999.7	14.5		8	13			
SS ESSO SAN FRANCISCO	AMERICAN	21	32.0 N	76.0 W	12	23	50	2 NM	18	1003.1	21.0	22.7	8	16.5			
MV WESER	GERMAN	22	40.8 N	60.5 W	18	07	44	2 NM	61	1007.0	11.0	18.0	9	6.5			
SS AFRICAN SUN	AMERICAN	22	40.0 N	63.3 W	18	09	45	.5 NM	21	997.6	13.4	16.7	8	14.5	07	12	19.5
USCGC ACTIVE	AMERICAN	22	42.3 N	65.2 W	18	06	47	10 NM	02	1010.8	0.0	3.3	5	11.5			
USCGC CAMPBELL	AMERICAN	22	43.4 N	68.9 W	21	03	M 41	5 NM	02	1016.2	1.0	3.3	8	18			
SS CHARLESTON	AMERICAN	22	37.1 N	73.8 W	12	34	45	5 NM	02	1003.1	5.6	12.2					
SS ESSO BANGOR	AMERICAN	22	36.1 N	74.9 W	18	34	44	5 NM	02	1013.2	7.0	10.0	4	6.5	04	6	10
MV SERAFIN TOPIC	LIBERIAN	22	48.3 N	35.4 W	18	33	M 80	.5 NM	65	982.0	9.0	11.0	7	16.5			
MV MELVIN H BAKER	LIBERIAN	22	38.8 N	72.3 W	18	36	45	2 NM	97	1002.0	3.9	13.0	9	16.5			
MV WESER	GERMAN	23	40.3 N	65.5 W	12	03	46	.5 NM	61	997.0	2.3	5.0	10	19.5			
SS CHARLESTON	AMERICAN	23	36.9 N	73.5 W	00	35	48	5 NM	02	1011.2	5.0	13.3					
SS AMER LEGEND	AMERICAN	23	41.0 N	64.5 W	18	03	50	1 NM	07	994.5	5.0	13.3	12	24.5			
SS AMER ACCORD	AMERICAN	23	40.5 N	68.1 W	12	03	55	1 NM	20	1000.5	1.7	7.2	12	26			
USCGC ACTIVE	AMERICAN	23	41.2 N	67.2 W	12	03	60	.5 NM	84	1002.4	0.0	0.6	14	26			
SS AFRICAN SUN	AMERICAN	23	41.0 N	63.6 W	18	06	60	.5 NM	65	991.5	6.7	11.2	12	24.5	06	12	36
USCGC GRESHAM	AMERICAN	23	37.8 N	71.8 W	00	33	M 58	.25 NM	61	1003.8	9.5	22.0	11	29.5			
USCGC CAMPBELL	AMERICAN	23	43.2 N	65.1 W	12	03	M 58	2 NM	61	1007.4	0.6	1.8	11	28			
SS FORTALEZA	AMERICAN	23	33.8 N	74.2 W	00	33	50	5 NM	15	1010.5	11.3	22.7	8	19.5			
SS J LOUIS	LIBERIAN	23	42.6 N	59.8 W	00	06	45	2 NM	07	1009.0	4.5	3.5	4	14.5			
MV FERNDALE	NORWEGIAN	23	33.9 N	64.4 W	12	26	52	> 25 NM	02	998.6	13.8	20.0	9	19.5			
MV MELVIN H BAKER	LIBERIAN	23	39.5 N	71.0 W	00	36	45	2 NM	51	1008.0	6.7	13.0	9	16.5			
MV SERAFIN TOPIC	LIBERIAN	23	49.8 N	32.8 W	06	33	M 72	.5 NM	64	995.0	5.0	8.0	12	39			
USCGC GRESHAM	AMERICAN	24	37.6 N	72.4 W	00	36	M 45	5 NM	02	1015.6	10.9	21.0	11	28			
USCGC ACTIVE	AMERICAN	24	41.7 N	66.9 W	00	04	48	5 NM	02	1012.2	3.9	1.1	5	8			
SS AFRICAN SUN	AMERICAN	24	41.3 N	63.8 W	00	03	50	5 NM	02	999.0	4.4	11.1	12	24.5	09	10	29.5
SS AMER LEGEND	AMERICAN	24	40.6 N	67.1 W	00	34	55	5 NM	07	1006.1	5.0	13.9	12	23			
SS WARRIOR	AMERICAN	24	39.8 N	64.7 W	06	01	55	5 NM	02	997.3	8.7	21.2	4	14.5	04	>13	39
SS CAVALA	LIBERIAN	24	36.0 N	72.7 W	06	34	45	10 NM	02	1017.0	13.0	22.2	8	10	35	12	16.5
SS MOBIL GAS	AMERICAN	24	37.6 N	71.8 W	12	36	45	10 NM	02	1019.0	13.7	22.2	14	19.5			
MV PUEBLA	MEXICAN	24	42.8 N	21.8 W	06	25	42	10 NM	81	1011.0	12.0	10.0	4	13			
MV SERAFIN TOPIC	LIBERIAN	24	49.8 N	25.0 W	06	32	M 42	1 NM		1008.0	5.0	11.0	12	29.5			
SS DOCTOR LYKES	AMERICAN	25	33.3 N	44.2 W	18	20	50	5 NM	02	1009.8	18.9	17.8	12	23			
SS ESSO HUNTINGTON	AMERICAN	26	34.4 N	74.6 W	00	16	45	5 NM	03	1011.2	19.5	23.3	4	8			
MV SEA WITCH	AMERICAN	27	41.2 N	63.2 W	18	35	45	5 NM	02	999.3	15.6	14.2	8	10			
SS MASON LYKES NEW	AMERICAN	27	25.8 N	76.9 W	12	27	M 45	10 NM	02	1009.8	23.9	21.1	3	5			
USCGC ACTIVE	AMERICAN	27	41.3 N	69.0 W	12	02	45	5 NM	02	1004.1	4.4	4.4	3	5	02	6	18
SS BOSTON	AMERICAN	27	37.2 N	72.6 W	18	03	50	5 NM	05	1011.0	12.0	20.0	9	14.5			
MV ALERT	AMERICAN	27	39.6 N	72.2 W	12	04	M 44	5 NM	07	1005.8	6.2	7.7	6	14.5	04	6	24.5
SS TRANSHAWII	AMERICAN	28	36.9 N	73.2 W	00	02	45	2 NM	62	1019.3	11.2	20.0	6	19.5			
USCGC ACTIVE	AMERICAN	28	41.9 N	69.0 W	00	03	44	5 NM	01	1019.0	2.8	3.9	5	13			
MV ALERT	AMERICAN	28	39.9 N	70.9 W	00	03	M 49	5 NM	01	1017.6	4.4	12.3	6	8			
SS UNIVERSE PORTUGAL	LIBERIAN	31	27.9 N	17.5 W	18	01	47	10 NM	02	1013.5	17.8	18.4	9	10			
OCEAN STATION VESSELS																	
ATLANTIC B																	
USCGC BOUTWELL	AMERICAN	1	56.5 N	51.0 W	00	32	M 44	200 YD	73	1005.3	- 3.7	3.3	6	11.5			
USCGC BOUTWELL	AMERICAN	3	56.5 N	51.0 W	09	30	M 41	5 NM	26	1015.9	- 7.2	2.5	9	21			
USCGC CHAUTAUQUA	AMERICAN	20	56.5 N	51.1 W	18	02	44	5 NM	07	1001.8	- 1.0	3.0	8	18			
ATLANTIC C																	
USCGC HAMILTON	AMERICAN	1	52.0 N	35.7 W	12	20	M 47	.5 NM	61	988.7	8.8	4.4	9	16.5	14	9	14.5
USCGC HAMILTON	AMERICAN	2	52.7 N	35.5 W	06	27	M 45	5 NM	02	1004.0	0.5	3.9	8	14.5	XX	X	14.5
USCGC ESCANABA	AMERICAN	23	52.7 N	35.5 W	09	32	M 46	5 NM	85	1001.3	2.4	3.5	6	18			
ATLANTIC D																	
USCGC OWASCO	AMERICAN	1	44.0 N	41.0 W	12	19	50	5 NM	07	1012.1	15.8	15.3	7	18			
USCGC INGHAM	AMERICAN	11	43.5 N	42.8 W	03	31	M 45	2 NM	88	1017.8	2.6	13.8	7	14.5			
USCGC INGHAM	AMERICAN	13	43.0 N	41.5 W	18	18	M 52	1 NM	61	995.8	13.0	13.0	7	16.5	30	7	8
USCGC INGHAM	AMERICAN	22	43.8 N	40.9 W	12	29	M 52	5 NM	80	1009.6	7.0	14.1	6	18	22	6	10
ATLANTIC H																	
USCGC GRESHAM	AMERICAN	18	38.0 N	71.0 W	21	27	M 41	5 NM	25	995.2	8.0	13.4	10	23			
USCGC GRESHAM	AMERICAN	22	38.0 N	71.0 W	15	03	M 70	200 YD	81	986.6	14.0	23.3	11	28			
USCGC GRESHAM	AMERICAN	26	38.0 N	71.0 W	21	17	M 45	1 NM	63	997.5	17.5	22.9	10	19.5			
USCGC GRESHAM	AMERICAN	27	38.0 N	71.0 W	21	03	M 55	2 NM	61	1004.3	10.0	22.5	9	19.5			
USCGC GRESHAM	AMERICAN	28	38.0 N	71.0 W	00	01	M 52	1 NM	61	1008.8	10.1	22.5	10	26			
NORTH ATLANTIC OCEAN		APR.															
USCGC TANEY	AMERICAN	2	50.0 N	39.5 W	12	03	M 42	200 YD	61	1011.9	7.4	6.7	8	10			
SS MOBIL VALIANT	LIBERIAN	5	37.5 N	72.6 W	18	28	45	10 NM	02	1003.0	12.0	24.0	10	13			
SS MOBIL POWER	AMERICAN	5	34.7 N	73.6 W	00	22	45	5 NM	02	1001.4	21.7	23.3					
MV EDE SOTTORF	GERMAN	7	38.3 N	60.9 W	18	27	44	2 NM	02	1006.0	15.0		13	10			
MV EDE SOTTORF	GERMAN	8	38.0 N	58.7 W	00	27	44	10 NM	01	1007.1	16.5		13	11.5			
SS ESSO PUERTO RICO	PANAMANIAN	8	38.9 N	74.1 W	18	36	M 48	5 NM	03	999.0	4.9		12	23			
MV ALERT	AMERICAN	9	43.9 N	48.8 W	18	15	M 46	.25 NM	42	995.6	6.7	0.2	9	14.5			
SS DOCTOR LYKES	AMERICAN	14	38.0 N	40.9 W	00	17	50	5 NM	01	1024.5	17.3	17.3	4	5	13	7	10
SS EXPORT AIDE	AMERICAN	15	37.0 N	34.2 W	06	32	64	10 NM	50	1011.9	15.0	18.3					

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves+ Period sec	Sea Waves+ Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH ATLANTIC OCEAN		APR.															
MV ESSO BARCELONA	PANAMANIAN	15	37.4 N	51.9 W	06	28	M 41	5 NM	02	1009.5	15.5	18.0	6	10	25	12	19.5
SS AMER LEGEND	AMERICAN	16	41.9 N	46.0 W	00	23	48	5 NM	02	1006.7	8.9	14.5	7	19.5			
SS PORTLAND	AMERICAN	17	33.8 N	76.8 W	18	19	45	5 NM	05	1000.0	17.0	24.0	7	11.5			
SS SOLON TURMAN	AMERICAN	18	36.5 N	02.5 W	00	07	M 45	5 NM	02	1015.6	13.3	14.4	3	8	09	>13	24.5
SS BRINTON LYKES	AMERICAN	18	20.1 N	84.5 W	18	11	M 45	10 NM	02	1015.2	27.3	28.0	3	5			
SS SEALAND ECONOMY	AMERICAN	23	42.2 N	31.9 W	06	13	M 46	2 NM	62	1000.0	13.4	15.6			XX	X	10
OCEAN STATION VESSELS																	
ATLANTIC C																	
USCGC TANEY	AMERICAN	8	52.5 N	34.9 W	03	10	M 42	.5 NM	10	1018.2	7.4	5.7	8	11.5			
USCGC TANEY	AMERICAN	11	53.7 N	36.9 W	06	12	M 41	5 NM	61	1012.2	7.5	5.6	8	10			
ATLANTIC D																	
USCGC CAMPBELL	AMERICAN	17	45.3 N	43.0 W	12	26	M 45	5 NM	80	1002.9	6.3	14.1	10	21			
GREAT LAKES VESSELS																	
SS BENJAMIN F FAIRLESS	AMERICAN	10	45.2 N	82.5 W	12	06	M 44	.5 NM	74		- 6.0	1.0	10	8			
SS EDMUND FITZGERALD	AMERICAN	17	45.2 N	83.2 W	00	25	M 44	5 NM	02		8.0	3.0	4	3			

+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: These observations are selected from those with winds of 41 kt or higher. In cases where a ship reported more than one observation a day with such winds, the observation with the highest wind speed was selected. In cases where two or more observations had the same wind speed, the one at 1200 GMT or the one closest to 1200 GMT was chosen. If this method still did not break a tie, the one with the lowest barometric pressure was picked. The data for the Ocean Station Vessels are based on 3-hr observations. In a good many cases, the maximum wind speeds given in the U.S. Ocean Station Climatological Data tables are higher because these are based on the Summary of Day entries.

Table 12

U.S. Ocean Station Vessel Climatological Data, North Pacific

Ocean Weather Station 'NOVEMBER' 30°00'N 140°00'W — **March and April, 1973**

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
MAR	14.0	27 12	16.5	19.5	03 00	5.7	17 09	11.3	14.9	23 18	16.2	18 12	17.9	18.6	*01 03	- 3.7	27 12	- 1.4	1.2	03 00
APR	15.3	30 09	17.2	20.1	08 21	7.0	14 15	12.4	18.2	08 21	16.7	*15 12	18.4	21.8	17 15	- 5.0	23 12	- 1.2	2.1	08 21

MONTH	MEANS AND EXTREMES: PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER: PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
MAR	1020.8	01 00	1029.0	1034.1	12 18	7.2	20.6	37.6	34.5	12.9	22.7	32.5	32.0	12	12	0	0	0	0	0	0	17	1.5	194
APR	1010.2	08 00	1026.4	1033.2	01 18	8.1	19.1	30.6	42.1	16.7	17.7	27.8	37.8	8	8	0	0	0	0	0	0	22	4.3	209

** VV=00-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

MAR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.5	8.6	13.5	.9	.0	.0	23.6	12.4
NE	.0	6.2	31.1	6.7	.0	.0	43.9	16.4
E	.5	3.2	7.1	.0	.0	.0	10.8	12.7
SE	.5	3.5	.1	.0	.0	.0	4.1	7.5
S	.9	2.6	.0	.0	.0	.0	3.5	5.4
SW	.6	1.5	.0	.0	.0	.0	2.2	6.0
W	.5	3.4	.0	.0	.0	.0	3.9	5.9
NW	.5	1.9	1.8	.1	.0	.0	4.4	11.2
CALM	3.6	.0	.0	.0	.0	.0	3.6	.0
TOTAL	7.7	30.9	53.6	7.7	.0	.0	100.0	13.0

NUMBER OF OBS 194; MAX WIND: DIR 030, SPEED 25, DA HR *17 2300; VECTOR SPEED 10.3; MEAN DIR 035 (DIR IN DEGREES)

APR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.7	3.9	4.8	.0	.0	.0	9.4	11.1
NE	1.7	13.6	35.2	1.4	.0	.0	51.9	13.8
E	.7	5.9	14.1	2.4	.0	.0	23.1	13.6
SE	.2	1.0	2.3	2.0	.0	.0	5.5	17.6
S	.0	.0	1.0	.4	.0	.0	1.3	17.4
SW	.5	.0	.6	.1	.0	.0	1.2	12.1
W	.0	.0	1.9	2.3	.0	.0	4.2	20.7
NW	.5	.5	1.0	.0	.0	.0	1.9	11.3
CALM	1.4	.0	.0	.0	.0	.0	1.4	.0
TOTAL	5.7	24.9	60.8	8.6	.0	.0	100.0	13.7

NUMBER OF OBS 209; MAX WIND: DIR 130, SPEED 28, DA HR 05 0000; VECTOR SPEED 9.5; MEAN DIR 059 (DIR IN DEGREES)

Wave

MAR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.4	18.6	4.4	.9	.0	.0	.0	.0	24.2
NE	.6	14.4	22.9	.0	.0	.0	.0	.0	38.0
E	1.5	4.4	4.0	.0	.0	.0	.0	.0	9.9
SE	.0	5.2	.0	.0	.0	.0	.0	.0	5.2
S	.0	1.2	.0	.0	.0	.0	.0	.0	1.2
SW	.1	1.3	.0	.0	.0	.0	.0	.0	1.4
W	1.4	2.4	.0	.0	.0	.0	.0	.0	3.9
NW	1.0	7.2	4.3	.1	.0	.0	.0	.0	12.6
IND	1.5	1.5	.0	.0	.0	.0	.0	.0	3.1
CALM	.5	.0	.0	.0	.0	.0	.0	.0	.5
TOTAL	7.2	56.2	35.6	1.0	.0	.0	.0	.0	100.0

NUMBER OF OBS 194 IND=INDETERMINATE

APR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	4.5	4.8	.7	.0	.0	.0	.0	.0	10.0
NE	8.6	34.1	8.9	.0	.0	.0	.0	.0	51.6
E	1.6	17.0	3.1	.0	.0	.0	.0	.0	21.7
SE	.6	.5	1.9	2.5	.0	.0	.0	.0	5.5
S	.0	.0	1.0	.4	.0	.0	.0	.0	1.3
SW	.0	.2	.5	.0	.0	.0	.0	.0	.7
W	.0	2.5	1.8	.0	.0	.0	.0	.0	4.3
NW	.5	1.2	1.3	.0	.0	.0	.0	.0	3.0
IND	.5	1.0	.0	.0	.0	.0	.0	.0	1.4
CALM	.5	.0	.0	.0	.0	.0	.0	.0	.5
TOTAL	16.7	61.2	19.1	2.9	.0	.0	.0	.0	100.0

NUMBER OF OBS 209 IND=INDETERMINATE

MAR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	4.6	47.4	31.4	1.0	.0	.0	.0	.0	84.5
6-7	1.0	7.2	3.1	.0	.0	.0	.0	.0	11.3
8-9	.0	.0	1.0	.0	.0	.0	.0	.0	1.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	1.5	1.5	.0	.0	.0	.0	.0	.0	3.1
TOTAL	7.2	56.2	35.6	1.0	.0	.0	.0	.0	100.0

NUMBER OF OBS 194; MAX WAVE HEIGHT: HGT 3.0, PER 5, DIR 340, TYPE SEA, DA HR 20 00; IND=INDETERMINATE (DIR IN DEGREES)

APR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	16.7	58.4	9.1	2.9	.0	.0	.0	.0	87.1
6-7	.0	1.9	9.1	.0	.0	.0	.0	.0	11.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	1.0	.0	.0	.0	.0	.0	1.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	1.0	.0	.0	.0	.0	.0	.0	1.0
TOTAL	16.7	61.2	19.1	2.9	.0	.0	.0	.0	100.0

NUMBER OF OBS 209; MAX WAVE HEIGHT: HGT 3.0, PER 5, DIR 130, TYPE SEA, DA HR 05 00; IND=INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

Table 13
Selected Gale Observations, North Pacific
March and April 1973

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves† Period sec	Sea Waves† Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH PACIFIC OCEAN		MAR.															
SS JOHN B WATERMAN	AMERICAN	1	45.1 N	168.6 E	00	11	48	.5 NM	43	980.0	2.8	3.3	6	29.5			
MV HONSHU MARU	JAPANESE	1	42.7 N	133.7 W	00	27	M 42	5 NM	02	1002.5	9.5	10.5	9	16.5	27	>13	26
SS THOMAS E CUFFE	AMERICAN	1	37.9 N	160.2 E	12	35	M 45	5 NM	02	977.0	6.7	12.2					
SS LOS ANGELES	AMERICAN	2	38.7 N	165.2 E	12	23	45	10 NM	96	991.8	7.2	13.3	3	5	26	10	16.5
MV HONSHU MARU	JAPANESE	2	46.1 N	143.3 W	18	31	M 42	5 NM	03	1002.0	7.0	8.0	7	13	32	10	18
SS WASHINGTON MAIL	AMERICAN	4	34.7 N	148.8 E	06	34	45	10 NM	02	1011.2	11.7	16.7	5	10	34	12	29.5
SS PANAMA	AMERICAN	4	29.0 N	162.0 E	12	27	43	5 NM	01	1013.2	15.7	18.9	5	11.5	27	< 6	14.5
SS LOS ANGELES	AMERICAN	5	41.7 N	176.1 W	00	15	50	.5 NM	65	985.4	11.1	11.0	5	10	11	>13	24.5
SS WASHINGTON MAIL	AMERICAN	5	36.2 N	160.3 E	12	12	48	.25 NM	43	983.1	11.1	15.0	14	32.5			
MV LA SALLE	AMERICAN	5	32.9 N	152.0 E	06	20	60	1 NM		988.2	16.7	18.9	6	29.5			
MV HONSHU MARU	JAPANESE	5	49.6 N	163.2 W	12	13	M 45	1 NM	60	1001.0	3.5	3.5	8	16.5	11	12	23
SS MALLORY LYKES NEW	AMERICAN	5	28.6 N	150.5 E	00	19	M 43	5 NM	03	1006.9	18.3	17.8	12	14.5			
MV PACKING	LIBERIAN	5	46.0 N	171.8 W	18	24	M 50	200 YD	64	976.0	4.0	5.5	14	29.5			
SS MONTANA	AMERICAN	5	31.2 N	157.5 E	18	24	45	10 NM	02	994.9	16.7	18.3					
SS PRES HARRISON	AMERICAN	5	30.9 N	150.6 E	12	27	50	10 NM	01	998.3	16.2	17.7	8	16.5	27	12	19.5
SS LABRADOR CLIPPER	BRITISH	6	27.1 N	166.8 E	12	27	45	5 NM	18	1006.0	22.1		XX	8			
MV HONSHU MARU	JAPANESE	6	50.0 N	167.2 W	00	19	M 46	1 NM	52	970.5	4.0	3.0	14	23	20	>13	31
SS PRES HARRISON	AMERICAN	6	31.2 N	148.8 E	00	32	60	10 NM	02	1002.4	11.2	16.7	12	24.5			
SS SAN JUAN VOYAGER	LIBERIAN	6	36.4 N	174.6 E	06	18	45	.5 NM	64	987.5	16.0	14.0	12	19.5			
SS PRES VAN BUREN	AMERICAN	6	30.5 N	155.2 E	06	28	45	5 NM	15	996.5	15.0	17.2	4	6.5	28	>13	29.5
MV MARCONAFLO MERCHANT	LIBERIAN	6	29.5 N	151.9 E	00	27	48	10 NM	02	1001.0	16.0	18.0					
SS PANAMA	AMERICAN	6	29.7 N	157.3 E	06	27	47	5 NM	82	996.2	17.6	18.9	7	14.5	28	9	19.5
MV PACKING	LIBERIAN	6	46.6 N	169.7 W	00	25	M 48	.25 NM		998.0	4.0	6.0	14	29.5			
SS CHINA BEAR	AMERICAN	6	29.0 N	173.8 E	12	19	M 42	5 NM	02	1003.7	20.0	17.8	3	5			
SS CALIFORNIA	AMERICAN	6	40.6 N	160.9 E	06	33	M 64	5 NM	03	978.7	4.4	7.5	14	29.5			
SS MALLORY LYKES NEW	AMERICAN	6	30.9 N	146.0 E	00	31	M 50	5 NM	03	1008.1	10.6	17.2	14	19.5			
SS BROOKLYN	AMERICAN	7	55.7 N	139.7 W	00	13	45	10 NM	60	1003.7	5.0	5.5	7	10	13	9	13
SS CHINA BEAR	AMERICAN	8	29.6 N	158.1 E	18	23	M 42	10 NM	25	1002.8	17.2	16.7	5	8	33	9	13
SS CHINA BEAR	AMERICAN	9	30.0 N	156.6 E	00	25	M 47	2 NM	07	996.3	15.6	16.1	4	6.5	25	7	19.5
SS CHICAGO	AMERICAN	9	29.9 N	165.3 E	06	19	55	10 NM	03	1009.3	18.3	18.9	10	19.5			
SS ORIENTAL PEARL	LIBERIAN	9	29.8 N	156.6 E	00	23	60	1 NM	54	1001.0	13.3	18.2	9	19.5			
MV OCEAN PROSPER	LIBERIAN	9	29.3 N	163.2 E	00	18	45	5 NM	07	1008.4	19.5	18.8	5	10			
SS MONTANA	AMERICAN	9	34.2 N	141.5 E	00	33	45	10 NM	02		8.9	18.3	5	8			
SS HAWAII	AMERICAN	9	33.2 N	167.0 E	12	23	52	5 NM	03	984.8	13.9	16.7	9	31			
SS LABRADOR CLIPPER	BRITISH	9	28.7 N	156.0 E	06	28	47	5 NM	15	1008.3	20.2		8	19.5			
SS INDIAN MAIL	AMERICAN	9	32.3 N	138.9 E	00	33	M 45	5 NM	02	1020.0	11.1	18.3	7	13			
SS GREAT REPUBLIC	AMERICAN	9	33.5 N	172.4 E	12	15	42	10 NM	02	994.2	15.6	14.5	5	8	16	9	19.5
MV YGUAZU	LIBERIAN	10	45.4 N	170.8 W	18	24	48	5 NM	03	995.0	6.0						
SS LOS ANGELES	AMERICAN	10	47.0 N	136.0 W	12	25	55	5 NM	02	1000.0	7.2	8.9	8	16.5			
MV TRANSOCEAN TRANSPORT	PHILIPPINE	10	47.4 N	175.5 E	12	05	M 45	5 NM	02	961.6	3.0	4.0	12	23			
SS JOSEPH D POTTS	AMERICAN	10	46.6 N	131.2 W	12	27	45	5 NM	25	1000.0	5.3	5.9	5	13	28	7	16.5
MV FORTUNSTAR	LIBERIAN	10	36.3 N	171.3 E	00	21	M 45	5 NM	03	1001.5	9.0						
MV FIGARO	SWEDISH	10	37.3 N	176.5 E	00	25	50	.5 NM	12	987.9	9.0	11.0	12	19.5			
MV YGUAZU	LIBERIAN	11	45.3 N	171.1 W	00	24	50	5 NM	02	998.0	6.0						
SS LOS ANGELES	AMERICAN	11	47.8 N	130.1 W	06	01	45	10 NM	02	1010.5	8.3	8.9	8	19.5	27	10	19.5
MV TRANSOCEAN TRANSPORT	PHILIPPINE	11	47.6 N	173.0 E	00	30	M 42	5 NM	02	988.0	2.5	3.0	12	23			
SS WASHINGTON MAIL	AMERICAN	11	46.7 N	139.1 W	00	31	42	10 NM	02	1024.0	7.8	7.8	5	13			
MV SYUKO MARU	JAPANESE	11	47.4 N	168.5 W	18	22	M 50	10 NM	03	1008.5	7.0	5.0	12	21			
MV CARMEN	SWEDISH	11	51.2 N	167.8 W	18	25	50	1 NM		984.5	4.1	3.0	XX	14.5	25	>13	29.5
SS JOSEPH D POTTS	AMERICAN	11	47.9 N	132.1 W	00	33	45	5 NM	26	1000.7	5.7	5.4	7	14.5	28	13	29.5
MV CARMEN	SWEDISH	12	51.3 N	167.4 W	00	27	50	1 NM		1002.0	4.6	3.0	14	26			
SS PHIL MAIL	AMERICAN	12	40.3 N	176.0 E	00	34	41	2 NM	61	995.9	6.2	8.3			34	X	24.5
MV SKAUSUND	NORWEGIAN	12	41.0 N	180.0 E	12	28	45	10 NM	02	1008.8	7.0	6.0					
SS MONTEREY	AMERICAN	12	31.3 N	128.3 W	06	34	50	10 NM	01	1022.2	11.3	14.5	12	19.5			
SS HAWAII	AMERICAN	12	40.2 N	173.5 W	18	27	45	10 NM	02	1013.9	8.4	10.6	6	10	31	10	18
MV YGUAZU	LIBERIAN	12	44.6 N	177.0 W	18	27	56	5 NM	03	999.2	6.0						
MV TRANSOCEAN TRANSPORT	PHILIPPINF	12	44.6 N	163.4 E	18	28	M 46	2 NM	18	1008.0	1.0	3.4	12	24.5			
SS TRENTON	AMERICAN	12	36.9 N	124.7 W	12	30	45	5 NM	02	1013.5	9.4	12.2	3	6.5			
MV BAY BRIDGE	SINGAPORE	13	44.4 N	172.1 W	00	26	44	5 NM	02	1002.5	7.0	7.5	8	16.5	26	13	23
MV DONA CORAZON II	PHILIPPINE	13	36.6 N	122.5 W	18	32	M 48	5 NM	01	1016.1	16.0	13.0	6	14.5			
MV EASTERN BUILDER	LIBERIAN	13	37.1 N	156.5 E	12	16	M 48	1 NM	59	1004.0	14.0	17.0	12	23			
MV MANDARIN VENTURE	LIBERIAN	13	43.3 N	160.6 E	21	11	M 52	5 NM	02	1007.0	3.5	4.0	10	16.5			
MV FERNSIDE	NORWEGIAN	13	55.2 N	145.2 W	00	27	M 44	10 NM	15	1010.5	2.0	3.0	4	8	27	9	14.5
MV YGUAZU	LIBERIAN	13	44.5 N	177.2 W	00	27	45	5 NM	02	1011.0	8.0						
SS WASHINGTON	AMERICAN	13	36.9 N	125.0 W	12	33	M 42	10 NM	02	1018.0	11.7	12.2	6	8			
SS CHEVRON CALIFORNIA	AMERICAN	14	58.0 N	147.2 W	18	28	45	10 NM	02	998.2	- 1.1	2.2	8	11.5			
MV TRANSOCEAN TRANSPORT	PHILIPPINE	14	43.7 N	155.7 E	00	10	M 52	.25 NM	61	979.6	3.0	5.6	16	29.5			
MV DONA CORAZON II	PHILIPPINE	14	37.3 N	123.0 W	00	32	M 48	5 NM	01	1014.1	11.8	13.0	10	14.5			
SS SAN JUAN	AMERICAN	14	37.1 N	155.1 E	12	25	50	10 NM	03	1002.6	9.5	13.4	14	16.5			
MV SUSAN MAERSK	DANISH	14	37.3 N	124.2 W	18	33	47	10 NM	01	1021.5	10.0	12.0	14	31			
MV MANDARIN VENTURE	LIBERIAN	14	43.3 N	160.9 E	00	11	M 65	1 NM	64	992.0	3.0	3.0	14	29.5			
MV FIGARO	SWEDISH	14	40.3 N	154.4 E	06	26	60	200 YD	58	970.6	4.2	6.0	12	19.5	26	12	23
MV FERNSIDE	NORWEGIAN	14	54.5 N	153.2 W	00	30	M 45	2 NM	16	997.0	0.2	2.0	4	10	27	8	13
MV VAN FORT	LIBERIAN	15	43.8 N	160.0 E	00	29	M 33	5 NM	02	985.3	3.0	3.0					
SS BROOKLYN	AMERICAN	15	58.6 N	149.5 W	00	28	33	2 NM	70	1000.3	- 4.1	3.8	9	16.5	28	11	19.5
SS CHEVRON CALIFORNIA	AMERICAN	15	58.6 N	149.8 W	06	27	35	.5 NM	02	999.5	- 6.6	2.2	13	29.5			
SS ARCTIC TOKYO	LIBERIAN	15	46.3 N	155.7 E	06	32	M 50	1 NM	86	997.0	- 1.0	1.0	9	10			
MV MANDARIN VENTURE	LIBERIAN	15	45.3 N	163.9 E	05	25	M 44	1 NM	18	991.0	4.0	3.0	6	14.5	24	13	26
SS INDIAN MAIL	AMERICAN	15	42.8 N	155.4 W	06	35	45	5 NM	02	1020.8	6.7	8.3	3	13	31	9	13
SS NEWARK	AMERICAN	16	51.5 N	131.1 W	00	23	50	5 NM	15	992.9	3.5	7.2	10	21			
ORIENTAL EMPIRE	LIBERIAN	16	40.4 N	171.5 E	00	31	M 35	5 NM	01	999.5	8.0	1.1					
SS OREGON MAIL	AMERICAN	16	51.9 N	172.6 E	12	24	45	2 NM	02	1001.6	2.3	1.6	5	19.5			
MV FERNSIDE	NORWEGIAN	16	50.9 N	166.7 W	00	29	M 43	2 NM	61	1013.8	4.2	2.0	3	6.5	22	6	11.5
SS INDIAN MAIL	AMERICAN	16	45.6 N	144.9 W	00	32	M 45	2 NM	85	1026.1	3.9	7.8	5	10	33	8	13
SS JOSEPH D POTTS	AMERICAN	16	58.4 N	149.2 W	00	28	43	5 NM	70	1006.1	- 7.5	1.1	7	10			
MV BALTO	NORWEGIAN	17	36.5 N	163.0 E	06	11	42	.25 NM	61	994.5	14.0	13.0					
SS OREGON MAIL	AMERICAN	17	51.3 N	169.2 E	00	24	50	5 NM	02	1004.7	1.1	1.1	14	26			
SS POLAR ALASKA	LIBERIAN	17	45.0 N	158.6 E	18	06	45	200 YD	75	980.0	- 3.0	4.0	6	16.5			
SS ORIENTAL ACE	LIBERIAN	17	37.4 N	158.6 E	06	12	41	5 NM	02	984.1	12.6	12.2	14	26	14	>13	32.5

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves Period sec	Sea Waves Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH PACIFIC OCEAN		MAR.															
MV YGUAZU	LIBERIAN	17	37.3 N	158.9 E	12	24	55	2 NM	07	987.0	10.0						
MV SKAUSUND	NORWEGIAN	17	36.3 N	150.8 E	00	36	55	.25 NM	63	986.1	9.0	14.0	14	36			
SS ELIZABETHPORT	AMERICAN	17	36.5 N	155.2 E	06	23	60	5 NM	02	978.0	12.8	16.7		29.5			
SS OREGON MAIL	AMERICAN	18	47.2 N	159.5 E	06	04	50	1 NM	72	974.3	0.6	2.7	6	14.5			
MV MONTIRON	LIBERIAN	18	46.2 N	162.5 W	00	26	M 41	10 NM	02	1002.9	7.7	0.5	8	13			
MV KATRINA	LIBERIAN	18	45.1 N	135.9 W	18	29	M 41	10 NM	27	992.0	7.5	9.0	9	10	29	10	13
MV HONSHU MARU	JAPANESE	18	43.4 N	155.0 E	06	31	M 46	2 NM	70	997.5	0.5	7.5	12	23	33	>13	26
SS ALASKAN MAIL	AMERICAN	18	48.1 N	158.4 E	06	05	50	.5 NM	72	983.4	1.1	2.2	7	14.5	05	9	19.5
SS JOSEPH D POTTS	AMERICAN	19	43.3 N	128.0 W	00	24	45	5 NM	02	998.6	6.7	6.7	4	10	27	< 6	10
SS PRES JEFFERSON	AMERICAN	20	32.9 N	151.2 E	00	29	M 41	10 NM	18	1019.6	12.2	16.7	6	13	29	9	16.5
SS PRES TAFT /NEW/	AMERICAN	20	33.2 N	168.5 E	18	27	55	5 NM	07	1009.1	15.6	15.0	10	16.5	27	10	19.5
MV HOEGH MERIT	NORWEGIAN	20	39.3 N	174.5 E	06	31	M 45	5 NM	02	994.0	10.0						
SS ELIZABETHPORT	AMERICAN	20	42.2 N	176.0 E	12	28	45	5 NM	07	991.5	5.0	7.8	3	11.5	31	8	19.5
MV CHERRY	GERMAN	20	36.8 N	172.1 E	06	31	47	5 NM	03	1003.0	12.0	17.0	14	16.5			
MV TRANSOCEAN SHIPPER	PHILIPPINE	20	35.5 N	145.9 E	06	32	50	10 NM	01	1024.5	9.5	15.6	7	6.5			
SS PRES TAFT /NEW/	AMERICAN	21	33.0 N	167.7 E	00	31	42	10 NM	02	1018.0	17.3	15.0	8	10	30	8	16.5
MV HOEGH MERIT	NORWEGIAN	21	40.6 N	178.4 W	06	32	M 42	.5 NM	69	992.5	3.0						
MV MONTIRON	LIBERIAN	21	44.3 N	178.0 W	00	27	M 47	5 NM	99	999.1	7.0	0.6	7	14.5	08	9	14.5
MV HARBOUR BRIDGE	SINGAPORE	21	35.0 N	179.4 E	06	28	M 41	5 NM	18	1009.2	10.0	15.0	4	8	29	9	13
MV BALTO	NORWEGIAN	21	41.0 N	168.4 W	18	27	55	.5 NM	60	999.1	6.0	11.0	14	32.5			
MV KASHU MARU	JAPANESE	22	40.5 N	163.3 W	00	26	M 45	1 NM		1006.0	10.0	10.5	8	13	29	>13	29.5
SS PRES TAFT /NEW/	AMERICAN	22	33.2 N	158.8 E	00	17	42	10 NM	02	1005.5	16.2	15.6	4	10	18	9	14.5
MV CHERRY	GERMAN	22	40.4 N	153.4 E	09	32	47	5 NM	81	994.0	7.5		12	26			
MV BALTO	NORWEGIAN	22	41.3 N	167.0 W	00	28	53	2 NM	60	1002.0	8.2	11.0					
MV MONTIRON	LIBERIAN	23	38.2 N	175.0 W	00	20	M 55	< 50 YD		999.7	15.0	1.4	9	16.5	10	9	16.5
SS ARCTIC TOKYO	LIBERIAN	23	53.3 N	172.7 E	18	05	M 55	50 YD	86	985.0	1.0	4.0	12	16.5			
SS THOMAS E CUFFE	AMERICAN	23	32.9 N	165.2 E	12	29	42	10 NM	01	1018.0	12.2	16.1	10	11.5			
SS WASHINGTON MAIL	AMERICAN	23	52.6 N	170.5 E	18	14	50	5 NM	02	977.3	0.0	3.3	8	11.5	14	12	13
MV TRUMPH	PANAMANIAN	23	42.0 N	158.0 E	18	30	M 42	5 NM	03	1010.2	0.5	8.0	12	14.5	36	12	21
MV WORLD PELAGIC	LIBERIAN	23	36.0 N	174.6 E	18	28	45	5 NM	15	1008.0	11.2	15.0	4	8	30	10	24.5
MV MONTIRON	LIBERIAN	24	38.0 N	172.4 W	00	27	M 47	1 NM	25	1000.5	9.0	1.4	9	14.5			
SS PRES TAFT /NEW/	AMERICAN	24	34.7 N	140.5 E	06	23	45	5 NM	02	998.3	18.3	18.9	5	13			
SS WASHINGTON MAIL	AMERICAN	24	51.8 N	167.6 E	00	04	50	2 NM	22	981.0	5.0	2.3					
MV WORLD PELAGIC	LIBERIAN	24	35.6 N	173.0 E	06	28	M 45	5 NM	15	1014.0	12.4	15.0	4	10	29	>13	32.5
SS ARIZONA	AMERICAN	26	39.6 N	173.0 E	18	25	45	5 NM	15	999.0	6.7	12.3	7	11.5			
MV TOYOTA MARU #5	JAPANESE	26	42.6 N	169.6 W	18	20	M 43	2 NM	61	1004.0	9.0	8.1	9	21			
SS ARIZONA	AMERICAN	27	40.0 N	175.6 E	00	25	45	10 NM	01	999.7	7.7	11.1	7	11.5			
MV LUNA MAERSK	DANISH	27	42.1 N	178.8 W	06	25	41	10 NM	15	994.5	7.5	9.0	8	19.5			
MV TOYOTA MARU #5	JAPANESE	27	41.6 N	174.6 W	18	24	M 43	10 NM	01	999.0	8.0	9.5	6	16.5	25	10	23
SS BROOKLYN	AMERICAN	28	55.6 N	139.4 W	12	14	50	2 NM	15	1003.7	5.5	6.2	8	16.5			
SS AMER MAIL	AMERICAN	28	50.6 N	139.1 W	18	18	M 45	.5 NM	47	1005.8	11.1	5.6	5	6.5			
MV LUNA MAERSK	DANISH	28	41.6 N	171.7 W	00	25	42	10 NM	81	1003.0	10.5	8.0	9	19.5			
MV TOYOTA MARU #5	JAPANESE	28	41.4 N	176.6 W	06	26	M 45	10 NM	02	1006.0	11.5	10.0	6	16.5	26	13	29.5
SS BROOKLYN	AMERICAN	29	53.6 N	134.6 W	00	16	55	1 NM	65	1006.4	7.2	7.2	9	16.5			
SS GOLDEN GATE	AMERICAN	29	35.5 N	121.9 W	00	32	58	5 NM	02	1015.9	13.4	11.1	6	21			
MV SPINDRIFT ISLE	GERMAN	29	33.6 N	158.8 E	12	24	52	5 NM	07	1017.2	16.2	16.0	6	16.5	22	>13	24.5
MV STAR ATLANTIC	NORWEGIAN	29	34.4 N	121.0 W	06	30	41	5 NM	01	1017.3	12.0	11.0		13	30	X	29.5
NORTH PACIFIC OCEAN		APR.															
SS WASHINGTON MAIL	AMERICAN	3	40.0 N	166.7 E	00	20	55	2 NM	10	1007.5	14.5	11.3					
MV UNION SUNRISE	CHINESE	3	51.1 N	172.1 W	18	17	M 42	5 NM	02	1021.4	3.0	3.0					
USCGC STATEN ISLAND	AMERICAN	3	59.9 N	175.9 W	18	15	M 43	2 NM	36	1002.3	- 0.2						
MV KATRINA	LIBERIAN	3	51.4 N	162.4 W	00	34	M 44	10 NM	02	1023.0	6.0	3.0	6	10	34	11	14.5
MV SADOHARU MARU	JAPANESE	4	36.3 N	155.0 W	18	36	M 42	5 NM	21	1018.0	8.5	13.0	9	13	03	13	14.5
MV CAP VILANO	GERMAN	4	31.6 N	148.0 W	12	17	47	1 NM	52	1004.0	18.0	20.0	10	18			
SS AMER CHARGER	AMERICAN	4	31.2 N	154.5 W	12	01	50	5 NM	51	1004.8	12.3	18.3	9	19.5	32	>13	29.5
SS OREGON	AMERICAN	4	35.5 N	154.0 W	20	01	60	5 NM	02	1006.8	11.2	13.3	14	24.5			
SS IDAHO STANDARD	AMERICAN	4	25.2 N	150.5 W	12	27	47	.5 NM	82	1011.0	17.7	22.8	5	10	21	10	13
SS MONTEREY	AMERICAN	4	28.2 N	146.2 W	18	16	45	2 NM	60	1008.0	20.6	20.0	6	14.5			
SS UNIVERSE KURE	LIBERIAN	5	27.6 N	155.7 W	12	32	45	5 NM	25	1009.0	16.0	21.0	6	13	32	8	16.5
SS SEATRAIN MAINE	AMERICAN	5	37.3 N	155.3 W	00	02	43	5 NM	02	1015.9	10.0	12.2	8	13			
MV SPINDRIFT ISLE	GERMAN	5	35.0 N	149.0 E	18	05	44	5 NM	02	1011.8	12.8	17.0	7	19.5			
MV SADOHARU MARU	JAPANESE	5	35.1 N	150.1 W	00	36	M 48	5 NM	03	1012.3	10.0	13.0	10	16.5			
SS GUAM BEAR	AMERICAN	5	31.5 N	148.0 W	18	21	50	5 NM	02	1000.7	15.6	17.7	7	13	20	10	14.5
SS AMER CHARGER	AMERICAN	5	32.6 N	154.5 W	00	34	50	2 NM	62	999.5	10.7	18.8	6	16.5	34	>13	32.5
SS MONTEREY	AMERICAN	5	30.2 N	142.7 W	06	16	50	5 NM	02	1011.2	18.9	18.9	8	16.5			
SS OREGON	AMERICAN	5	35.5 N	154.0 W	00	01	60	5 NM	02	1003.0	11.1	13.9	14	30			
SS MORMACGLEN	AMERICAN	5	32.5 N	157.8 W	06	01	45	10 NM	02	1014.0	13.8	15.0	5	10	36	>13	24.5
MV UNION SUNRISE	CHINESE	6	50.5 N	141.8 W	06	12	M 43	10 NM	00	1021.2	7.2	4.8					
SS GUAM BEAR	AMERICAN	6	31.4 N	148.7 W	00	24	45	5 NM	25	997.0	16.1	17.2	9	14.5			
SS GOLDEN GATE	AMERICAN	7	48.1 N	136.1 W	00	13	42	10 NM	02	1021.2	8.9	6.1	6	13			
MV EASTERN BUILDER	LIBERIAN	7	43.6 N	174.8 E	18	30	M 45	5 NM	70	1020.0	1.1	6.0	9	16.5	32	>13	32.5
SS SUMMIT	AMERICAN	8	55.0 N	162.3 W	00	14	45	50 YD	86	983.7	2.4	1.7	5	11.5			
MV DERWENTFIELD	BRITISH	8	53.9 N	177.8 E	18	32	50	5 NM	03	1003.5	0.5	4.0		13	XX	X	13
MV HONSHU MARU	JAPANESE	8	49.5 N	177.7 W	06	27	M 42	5 NM	02	993.5	3.0	3.0	7	14.5	27	12	21
MV DERWENTFIELD	BRITISH	9	53.8 N	177.5 E	00	33	55	1 NM	86	1009.0	0.0	4.0	14	23			
MV ELISABETH SCHULTE	GERMAN	9	48.5 N	168.5 E	18	16	45	1 NM	86	1000.0	2.0	0.0	5	10			
MV LIECHTENSTEIN	LIBERIAN	10	40.3 N	164.1 W	12	27	M 42	2 NM	81	1014.5	6.0	11.1	6	14.5			
MV ALEXANDER AGASSIZ	AMERICAN	10	16.2 N	94.9 W	00	35	M 45	5 NM	02	1011.5	25.6	28.3	6	11.5			
SS GEH YUNG	CHINESE	10	40.2 N	165.5 W	06	27	43	10 NM	03	1010.5	7.2		5	6.5	29	< 6	10
MV ELISABETH SCHULTE	GERMAN	10	49.3 N	171.1 E	00	16	44	.25 NM	73	996.5	2.2	0.0	5	10			
MV TRUMPH	PANAMANIAN	14	51.6 N	152.1 W	12	27	M 42	5 NM	03	1006.2	2.5	6.0	9	19.5			
MV JAPAN CADBO	LIBERIAN	14	48.9 N	171.9 E	00	03	46	.5 NM	71	986.5	3.1	3.0					
MV VAN ENTERPRISE	LIBERIAN	14	49.5 N	175.6 E	06	06	48	1 NM	73	988.0		3.0	5	19.5			
SS WASHINGTON MAIL	AMERICAN	14	53.8 N	139.6 W	18	28	45	5 NM	01	1001.0	6.7	6.0	8	11.5			
SS BROOKLYN	AMERICAN	15	54.7 N	137.5 W	00	28	50	2 NM	10	997.6	3.8	7.8	9	13			
MV JAPAN CADBO	LIBERIAN	16	42.6 N	157.2 E	06	30	50	5 NM	18	1023.0	8.5	7.0					
MV JAPAN CADBO	LIBERIAN	17	39.4 N	149.9 E	12	13	54	2 NM	64	998.0	11.0	12.0					
MV VAN ENTERPRISE	LIBERIAN	17	44.2 N	150.0 E	12	18	45	5 NM	04		2.0	1.0	5	13	18	12	23
SS WASHINGTON MAIL	AMERICAN	18	50.1 N	166.9 E	18	20	30	5 NM	02	1003.1	1.7	2.8					
MV KASHU MARU	JAPANESE	20	41.1 N	157.2 W	00	20	M 42	2 NM	21	1000.5	12.0	10.5	7	6.5	19	8	16.5
MV ASHBY MARU	JAPANESE	20	39.9 N	158.0 W	00	23	M 47	5 NM	03	1008.5	11.5	9.0	6	10			
SS HONGKONG MAIL	AMERICAN	20	54.2 N	157.5 W	18	05	45	2 NM	83	1003.0	1.6	3.3	7	19.5			
SS DAISHOWA MARU	JAPANESE	21	44.8 N	151.3 W	00	24	M 41	5 NM	02	1019.0	10.0	8.0	6	13			
MV MIDAS RHEIN	LIBERIAN	23	45.1 N	150.6 E	18	24	M 70	5 NM	00	1001.0		0.0	14	29.5			
MV FERNLEAF	NORWEGIAN	23	40.5 N	159.5 E	12	28	50	5 NM	01	1004.0	8.0		14	29.5			
MV ELISABETH SCHULTE	GERMAN	23	43.7 N	150.5 E	18	30	45	5 NM	02	1011.2	0.2						

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves+ Period sec	Sea Waves+ Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH PACIFIC OCEAN		APR.															
MV DONA ROSSANA	LIBERIAN	24	42.7 N	151.0 E	00	29	45	.5 NM	52	1012.8	4.0						
MV FERNLEAF	NORWEGIAN	24	40.5 N	158.0 E	00	27	55	1 NM	81	1002.5	6.0	7.0	6	14.5	24	>13	24.5
MV ELISABETH SCHULTE	GERMAN	24	42.3 N	149.0 E	00	30	45	10 NM	02	1022.1					XX	X	24.5
SS HONGKONG MAIL	AMERICAN	24	49.5 N	162.4 E	06	04	45	2 NM	83	1002.4	2.8	2.3	7	16.5			
MV EASTERN BUILDER	LIBERIAN	24	41.6 N	154.2 E	00	31	M 45	2 NM	70	1007.0	2.0	6.2	6	13	31	9	23
MV MIDAS RHEIN	LIBERIAN	24	46.5 N	154.7 E	12	01	M 50	5 NM	02	1012.5	- 1.3	0.0	14	26			
SS SGT ANDREW MILLER	AMERICAN	24	30.5 N	125.8 W	00	36	45	10 NM	02	1020.0	12.8	12.2	8	16.5	36	>13	29.5
SS TAEPING	GERMAN	25	44.0 N	173.8 W	12	11	45	2 NM	10	1014.3	9.0	7.5	6	6.5			
MV UNION SUNRISE	CHINESE	25	49.9 N	138.9 W	18	20	M 45	5 NM	03	998.4	8.0	5.0					
SS CANADA MAIL	AMERICAN	25	52.5 N	176.0 E	18	11	50	5 NM	02	977.3	2.0	3.0	10	18			
MV UNION SUNRISE	CHINESE	26	49.5 N	142.0 W	06	28	M 45	5 NM	02	1014.2	7.2	5.0					
SS CANADA MAIL	AMERICAN	26	50.8 N	172.9 E	12	25	50	5 NM	22	986.8	0.0	2.7	10	32.5			
MV MIDAS RHEIN	LIBERIAN	28	49.4 N	179.3 W	12	35	M 52	1 NM	59	1011.5	1.8	1.0	14	26			
MV MIDAS RHEIN	LIBERIAN	29	49.7 N	175.7 W	00	01	M 42	5 NM	02	1011.8	1.8	2.0	9	19.5	02	12	26
MV UNION SUNRISE	CHINESE	29	44.6 N	168.8 W	12	32	M 45	10 NM	03	1008.9	5.0	5.0					
USCGC WINONA	AMERICAN	30	38.0 N	123.8 W	06	33	M 45	5 NM	00	1005.0	10.0	10.6	3	3	33	< 6	14.5

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: These observations are selected from those with winds of 41 kt or higher. In cases where a ship reported more than one observation a day with such winds, the observation with the highest wind speed was selected. In cases where two or more observations had the same wind speed, the one at 1200 GMT or the one closest to 1200 GMT was chosen. If this method still did not break a tie, the one with the lowest barometric pressure was picked. The data for the Ocean Station Vessels are based on 3-hr observations. In a good many cases, the maximum wind speeds given in the U.S. Ocean Station Climatological Data tables are higher because these are based on the Summary of Day entries.

Rough Log, North Atlantic Weather

June and July 1973

ROUGH LOG, JUNE 1973--The mean pressure pattern in the North Atlantic this month was generally shifted northward and eastward. The gradient was also more intense, as the pressure of the Icelandic Low was deeper and the pressure of the Azores High was greater than normal. The 1006-mb Icelandic Low was centered over Iceland (where else?). This was approximately 1,200 mi northeast of its 1010.5-mb climatology position for June, which is on the coast of Labrador. The 1026-mb Azores High was over the Azores Islands near 39°N, 28°W, or about 600 mi northeast of its 1023.8-mb normal position. Although shifted and more intense, the basic pattern was near normal, a relatively small Low in the northern latitudes and a large High across the temperate latitudes. The pressure along the U.S. East Coast was normal, but higher pressure of about 4 mb covered most of Europe.

The total storm tracks were more numerous than normal, but were generally weak and diffuse. The storms moving across Canada and the Davis Strait-Baffin Bay area seemed to lack direction, moving in circles and loops, and, in general, did not move any further east than Greenland. The storms that came out the New England and Newfoundland area moved northeastward, over or east of Iceland and then northward. These followed the climatic path until the northward turn in the vicinity of Iceland. Normally, the tracks continue with a more easterly component. This is in agreement with the higher average pressure over the European area. The storms out of the U.S. Southeast and in the Mediterranean Sea were insignificant.

The departures from normal were closely alined with the pressure centers and storm tracks. A negative 7-mb anomaly was centered over Iceland in conjunction with the location of the Icelandic Low. The only other significant negative anomaly was 5 mb near Winnipeg, Canada. A ridge of positive departure with a 7-mb center, about 600 mi west of the Brest Peninsula, stretched northeastward from the central Atlantic across England and into the U.S.S.R. Positive 3- and 4-mb anomalies were centered both north and south of Newfoundland respectively.

No tropical cyclones occurred this month. Normally one tropical cyclone can be expected in June each 2 yr, and half will reach hurricane intensity.

This LOW appears to have formed near 41°N, 50°W, at 0000 on the 6th, when two weak LOWS, one to the north and one to the west, combined into one center. The pressure was 1014 mb at that time. This embryonic circulation was surrounded by multiple high-pressure cells, but 12 hr later it was making a place for itself, as it expanded its influence. The GRIPSHOLM found 35-kt northeasterly winds with rain at 44°N, 43.1°W, 140 mi north of the center. As the LOW moved northeastward, it passed south and east of Ocean Station Vessel "D," at 0000 on the 7th, and presented her with 40-kt northerly winds and 12-ft seas. The storm was deepening at 1200 on the 7th, near 45°N, 40°W (fig. 33), with a pressure of 1003-mb. It started curving westerly as it traced an S-shaped track, between the 6th and the 10th. At 1200 on the 7th, Ocean Station Vessel "D" reported 35-kt gales, and the ERLANGEN, at 42.7°N, 42.2°W, was buffeted by 40-kt gales. At 0000 on the 8th, "D" was still being stung by 40-kt gales as she and the storm circled each other. In the westerly movement the LOW filled considerably and weakened as it appeared the HIGHS would defeat her. The central pressure had risen to 1017 mb at 1200 on the 8th.

Although weakened, the storm persisted, and, late on the 9th, started again on a northeasterly track. At 1800 on the 9th, Ocean Station Vessel "D" again measured 35-kt gales. At this time, the storm came under the influence of more zonal upper air flow and started to speed off to the east. The 1005-mb tempest was at 54.5°N, 29.5°W at 1200 on the 11th. The DOCTOR LYKES, 300 mi to the south, received 35-kt

Figure 33.--The typical extratropical cyclone structure (cold front, warm front, and occlusion) can be seen in this LOW, centered near 45°N, 40°W on June 7.

gales and 16-ft seas along the cold front.

The 992-mb storm passed just north of the Hebrides late on the 12th, and 45-kt winds were reported. As the storm passed up the Norwegian Coast, Ocean Station Vessel "M" reported 30-kt gales, and coastal stations measured 30- to 40-kt gales. The LOW moved across the Barents Sea, the Kara Sea, and into the Laptev Sea (all in the Arctic Ocean), where it finally dissipated on the 22d.

The 6th was a good day for storms in the Atlantic, not ships. A little history first. Earlier in the month, a LOW moved out of Newfoundland toward Greenland. As it approached the southern tip, it split into two centers. One moved through the Denmark Strait on the 5th and left an elongated trough. It was in this trough that the 994-mb LOW that concerns us formed, at 1200 on the 6th. The center moved eastward and was north of Iceland late on the 7th. Early on the 7th, the ANNA JOHANNE, NIKOLAI KONONOV, and SAIMA DAN reported 35-kt gales. All these ships were south

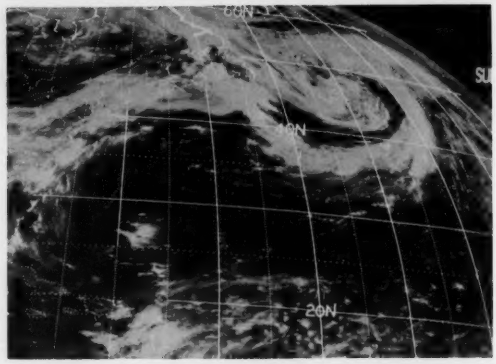

Figure 34.--The well-defined storm is located near 45°N, 42°W in this ATS-3 satellite picture. The cloud pattern of the frontal system is well ahead of the LOW.

of the LOW, stretching from near Kap Farvel to near the Faeroe Islands. The LOW continued to speed off to the northeast and was absorbed into another circulation late on the 8th.

A LOW and frontal system, that had occluded, tracked across Canada, and, at 0000 on the 10th, was on the eastern coast. A new LOW formed at the point of occlusion, just south of Gaspe Peninsula in New Brunswick. As the 998-mb LOW moved along the south coast of Newfoundland on the 11th, SEDCO "J" reported 35-kt gales. On the 12th, the LOW dawdled off the east coast as it deepened to 988-mb. The TRENTWOOD was bucking 35-kt winds, 18-ft seas, and 23-ft swells near 52.5°N, 49.6°W, to the north of the center.

The storm (fig. 34) picked up speed and moved on a southeastward course for about 24 hr, before turning northeastward. Early on the 13th, Ocean Station Vessel "C" was pounded by 45-kt winds. At midday CHARLIE was still measuring 40-kt sustained winds, as was the TRENTWOOD to the north of the center. South of the storm the LUDWIGSHAFEN and the VISURGIS reported 35-kt gales.

The LOW was located near 50.2°N, 35°W at 1200 on the 14th. The TRENTWOOD, which was keeping pace with the storm, had 40-kt gales and waves of 23 ft. The MANCHESTER CONCEPT and MANCHESTER COURAGE both found 35-kt gales north of the LOW. On the 15th, the RAMBURGH CASTLE, 500 mi south of the center, encountered 45-kt winds. Later that day, two ships that could not be identified reported 35- and 40-kt gales south of the center.

On the 17th, the LOW executed a loop southwest of Iceland, as another LOW raced around its periphery and became the dominant feature late on the 18th.

Monster of the Month--A stationary front stretched east-west across the Great Lakes on the 16th, and a wave developed east of Lake Huron that day. The wave raced along the front, and, by 0000 on the 17th, was west of Cape Cod. As it passed off the coast and over the water, it deepened rapidly, and was 990 mb off Nova Scotia at 1200. The ATLANTIC CHAMPAGNE was rolled by a 35-kt wind on her port side, in the warm sector of the system.

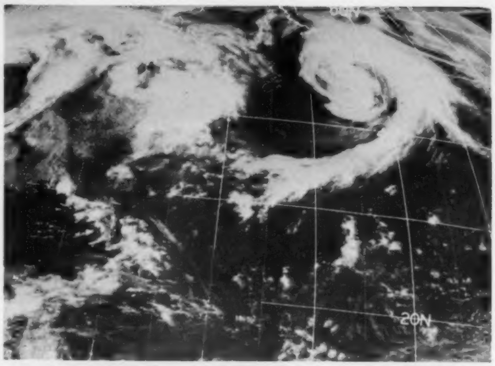

Figure 35.--As can be seen in this satellite photograph, at noon on the 18th, beautiful weather was to follow the passage of this LOW.

The next day (fig. 35), the pressure had plummeted to 978 mb. The HAMBURG had 40-kt gales as the front passed. In the next 24 hr, the LOW moved across Newfoundland, with the following ships reporting 35- to 40-kt gales: the ARALUCK, PASSAT, BOCKENHAIM, and the USCGC EVERGREEN, in addition to the GSAR and the 5PFH.

At 1200 on the 19th, the 989-mb LOW was at 52°N, 48°W. The JOHN CABOT, about 150 mi south of the center, was pummeled by 45-kt gales. Ocean Station Vessels "C" and "D" had 35- and 40-kt gales, with seas running about 15 ft. SEDCO I was blasted by 40-kt winds. On the 21st, the LOW continued its march toward the northeast, and was near 59°N, 32°W at 1200. The TOPSDALSFJORD, at 55.1°N, 48.6°W, was headed into 50-kt storm winds as a second LOW moved off the Labrador coast and tightened the gradient. On the 22d, the LOW moved over Iceland and deteriorated rapidly as the circulation broke down because of the interaction of the two LOWS.

This LOW is mainly significant because of its location, rather than the number of high wind reports.

The front associated with the storm described above was ahead of the center, and stretched southwestward between two HIGH centers. On the 20th, a 1020-mb wave formed near 34.5°N, 50.4°W. This was between the two HIGHS and south of their centers. The LOW progressed northeastward for the next 24 hr and deepened to 1012 mb. At 1200 on the 21st, the SACREMENTO, at 37.5°N, 45°W, about 100 mi north of the center, was lashed by 40-kt winds and heavy rain. By the 22d, the western HIGH extended eastward in an elongated shape, like a banana, pushing the LOW to the south. The LOW tried to hang on and fought a good battle, but the building HIGH was too powerful. The last vestige was an inverted trough on the 0000 chart of the 23d.

This last storm of June, like the one to the south, was born as a wave on a stationary front on the 28th. It was lucky, with a good chance for survival, because the only high-pressure area was south of it. The LOW matured fast; by 0000 on the 29th, the pressure had dropped to 990 mb and a good circulation was developing. The center was near 55°N, 35°W. Ocean

Figure 36.--This is a NOAA-2 radiometer strip in the visible spectrum. At 1228 on the 29th, the center of the LOW is near 55°N, 28°W. The sharp edge of the rear of the front (in the vicinity of 55°N) is especially interesting.

Station Vessel "C" received 40-kt gales. Twelve hours later (fig. 36), the pressure was 972 mb, and ships reported gale-force winds--DAGHESTAN, EDITH HOWALDT RUSS, SILVERSAND, and faithful Ocean Station Vessel "C."

The storm was due south of Iceland on the 30th. The GRIPSHOLM, 500 mi to the south, near 50.5°N, 20°W, was battered by 50-kt winds and 38-ft seas. North of her, Ocean Station Vessel "J" contended with only 35-kt gales and 18-ft seas.

As the LOW passed over the eastern tip of Iceland on July 1, the system was weakening, and the central pressure had risen to 986 mb. The wind reports had dropped off considerably, with only breezes plotted on the chart. Late in the day, a new LOW broke off to the north of the main center and moved northeastward, while the original center remained stationary over the south coast of Iceland until the 2d, where it perished.

Casualties--Thunderstorms and fog were the culprits

this month. Two lake freighters, the FRANK PURNELL and the SYLVANIA, collided in heavy fog on Lake Erie, at the mouth of the Detroit River, early on the 2d. The Norwegian tanker BOW ELM (6,792 tons) and the British tanker IRVING STREAM (15,185 tons) tried to occupy the same anchorage at the entrance to St. John's, Newfoundland harbor, during heavy fog on the 21st. The Panamanian steamer PACIFIC ALLIANCE (10,637 tons) went aground near Cabo San Antonio, Cuba during a storm, prior to the 14th. The 58,277-ton Liberian tanker CONOCO BRITANNIA was holed during fog in the Humber Estuary.

A series of violent thunderstorms on the 9th overturned hundreds of boats at Marblehead and Salem Harbors, Mass. Coast Guard cutters and helicopters pulled some 200 persons from the water. Logan Airport recorded 42-kt winds, but wind gusts over the harbors were estimated at up to 70 kt. Thunderstorms over Lake Michigan claimed three lives, as sailing and fishing boats were capsized.

ROUGH LOG, JULY 1973--The predominant feature in the North Atlantic this month, on every chart, was the large Bermuda-Azores High. It took up residence in mid-ocean, and could not be evicted, although it wandered around the neighborhood.

Cyclone activity was normal in the northern ocean and slightly above normal in the Hudson Bay-Davis Strait area. Most individual centers were short-lived, except for one that began a journey in North Dakota, on the 24th, which ended over the Faeroe Islands on August 2. The storms from central Canada and Hudson Bay generally remained in the Western Hemisphere. Only a few hardy ones made it east of Kap Farvel, and then only to be lost at sea.

The U. S. East Coast was very quiet, with only one significant extratropical storm. The majority of the storm centers were north of 55°N and had a northerly track once they neared the Davis Strait or the Norwegian Sea.

The mean pressure pattern for the month was a near carbon copy of the climatological pattern. The main feature was the Bermuda-Azores High, centered in the central Ocean. The mean pressure value of 1029 mb was about 4.4 mb higher than normal. The center was located near 40°N, 36°W, or about 500 mi northeast of its normal position at 35°N, 44°W. A 1007-mb low-pressure center was near Cape Chidley. This was within a few miles of the 1008.6-mb climatic center. The actual pressure gradient between the two mean centers was slightly less than 80 mi/mb, compared to the climatology mean of about 115 mi/mb. The pressure over the eastern United States and western Europe, including the Mediterranean Sea, was near normal.

The only major anomaly was a positive 6-mb center in the central North Atlantic, near the High center. This huge positive anomaly stretched from shore to shore, and from the tropics to Iceland. A positive 5-mb anomaly was located over the Barents Sea, and a positive 2-mb, over central Greenland. The negative anomalies were small and widely diffuse. The two major ones in the vicinity of the North Atlantic were only negative 3-mb pressure variations. One was centered over the Sahara Desert, near Mali, and the other was in the Greenland Sea, north of Jan Mayen Island.

Slightly less than one tropical cyclone occurs each year, on the average; 34 in the last 42 yr. Half of these will develop to hurricane strength. This year, it was hurricane Alice, which formed on the first day of the month.

This was a quiet month for most ships in the North Atlantic, 40 kt being the maximum winds, associated with extratropical cyclones, plotted on the weather charts. Most of the LOWS were small, relatively weak, and had short lifespans.

The first LOW that developed gale-force winds was analyzed south of Cape Sable, on a cold front on the 12th. The front stretched southward out of a LOW in northern Quebec. A long trough stretched to the south with the front, and a 1000-mb LOW formed. At 1200 on the 12th, the center was near 42.5°N, 64.8°W. South of the center, near 40.3°N, 61°W, the CITY OF OTTAWA reported 40-kt gales with 13-ft seas and 16-ft swells. At 0000 on the 13th, the center moved over Prince Edward Island, and the ship CGBV, just north of Sydney, N. S., had 35-kt winds and 16-ft seas.

By 1200 on the 13th, the two LOWS merged over Labrador into one 990-mb LOW. As the LOW moved northward, the frontal system pushed eastward, passing off St. John's, Newfoundland, late on the 13th. At 0000 on the 14th, SEDCO I also had 35-kt winds, prior to frontal passage.

This was now a large LOW covering most of eastern Canada, from Hudson Bay to Greenland. As the LOW moved to the north and then northwestward, another LOW moved south of it on the 14th. By the 16th, the second LOW had also curved north and then northwestward, and the two combined south of Frobisher.

On the 12th and 13th, a ridge of high pressure extended northeastward over the United Kingdom from the stationary HIGH northwest of the Azores. This ridge separated two low-pressure systems located between Greenland and Iceland and another over Spain. On the 13th, the HAMBURGER BRUCKE off Portugal was headed into a 40-kt gale. Later in the day, the ridge retreated rapidly, leaving an area of weak gradient between Iceland and Spain. A front which had been pushing against the ridge moved eastward, and on the 14th a wave formed near 46°N, 13°W. A 1001-mb LOW also developed at 55°N, 15°W. This circulation pulled in colder northern air, and the system intensified as it moved eastward. A ship reported 40-kt north winds at 49°N, 18°W. The ELBE, off Lisboa, contended with a thunderstorm.

The front moved on southeastward over the continent, but the LOW which had absorbed the wave held back over England. Southwest of Ireland, the AMERICAN ARCHER, headed home, was discomforted by 40-kt north winds on her starboard side. The waves were running 10 ft and the swell 18 ft. Almost due south, Ocean Station Vessel "K" was washed by rain driven by 35-kt gales. She had 16-ft waves.

On the 17th, the 998-mb LOW moved over Norway, and the PRESIDENT EDWARD JAMES ROYE had 35-kt gales off the coast. On the 18th, the LOW visited Sweden, and Finland on the 19th.

This was the only LOW that tracked most of the length of the U.S. East Coast. It had its inception as a 1009-mb wave over North Carolina on the 16th. Late that day, it moved off Cape Hatteras and developed a tight circu-

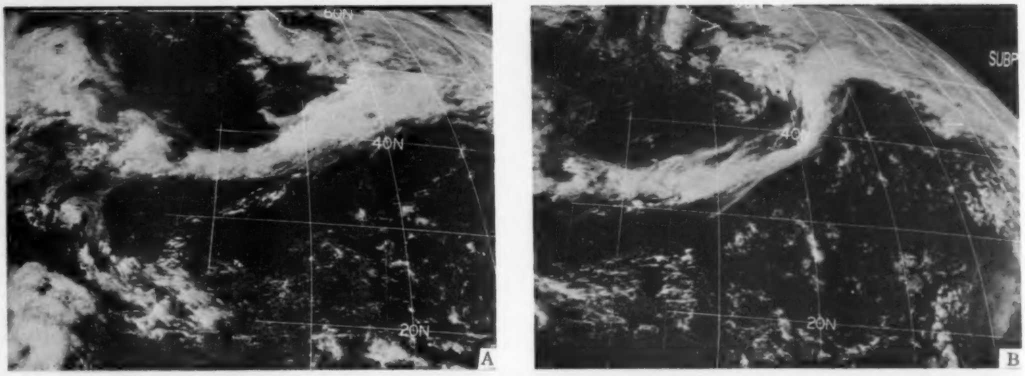

Figure 37.--Development of an extratropical cyclone (A), the front stretches across the Atlantic, at 1542 on the 23d, with no apparent wave. (B) Twenty-four hours later at 1540, development of the wave is clearly visible, near 48°N, 43°W.

lation. By 0000 on the 18th, the 1010-mb LOW was centered at 39°N, 69°W. A ship 200 mi northeast of the center was whipped by 40-kt gale winds. The LOW was being squeezed between a HIGH moving southeastward out of the Great Lakes and the permanent Bermuda-Azores High. As it was rolled northeastward between them, it rapidly weakened, and on the 20th gave up the fight.

A front stretched like a towline from South Carolina to Lands End. Several waves rolled along it, as if someone was whipping an end. They quickly faded and were not traceable from one chart to the next. On the 24th (fig. 37), as the line slackened, one was able to establish itself near 45°N, 46°W. The LOS ANGELES was just east of the front and south of the LOW at 1200, when she was overtaken by 40-kt southerly gales and heavy drizzle. The LOW was moving northeastward, and was at 50°N, 38.5°W by 0000 on the 25th. The MUSSON was hit by 40-kt south winds about 70 mi east of the center, and a ship found 35-kt north winds about the same distance west of the center.

The 996-mb LOW was headed almost due north. Late on the 25th, the center passed nearly over the DUKESGARTH . At 0000 on the 26th, she reported 40-kt winds south of the center. Although light, the seas were very confused with swell from two directions.

The LOW moved through the Denmark Strait on the 27th, and ended its career on the 29th, north of the Svalbard Islands.

This LOW's claim to fame was its longevity. It was born on the 24th, in North Dakota, as a 1012-mb LOW. On the 26th, it moved across Lake Superior. On the 27th, the LIMNOS reported from Lake Erie and the HALIFAX on the St. Lawrence River. The LOW moved steadily northeastward, and moved offshore near Hopedale early on the 29th, with a pressure of 994-mb.

As the LOW crowded against the 1036-mb HIGH in the mid-Atlantic, Ocean Station Vessel "C" radioed a report of 40-kt winds. On the 30th, the LOW split, with one center moving up Davis Strait and the other eastward along 59°N. As the LOW moved across its top, the HIGH center moved westward. On the 31st, the LOW center passed almost directly over Ocean Station Vessel "I." The pressure had then risen to 1010 mb, and the LOW was aging rapidly. Late on the 2d, the LOW was buried on the Faeroe Islands.

Subtropical cyclone Alfa got its start in a trough of low pressure off Charleston, S.C., early on the 30th. For a discussion of "subtropical cyclones," see page 203 of the July 1973 issue of the Mariners Weather Log. The reports from many ships helped identify and locate the small but intense storm as it moved up the East Coast (fig. 38).

Although there were no ship reports of gale-force winds or higher, reconnaissance, satellite, and ship pressure reports indicated a small but intense circulation. The early marine warnings probably enabled shipping to avoid the storm. Winds as high as 40-kt, with gusts to 50 kt, were estimated near the center. The cyclone moved rapidly northeastward off the coast until, late on the 31st, it slowed near 39°N, 70°W (fig. 39). It was in this area south of Cape Cod that it reached its maximum intensity on August 1, with a

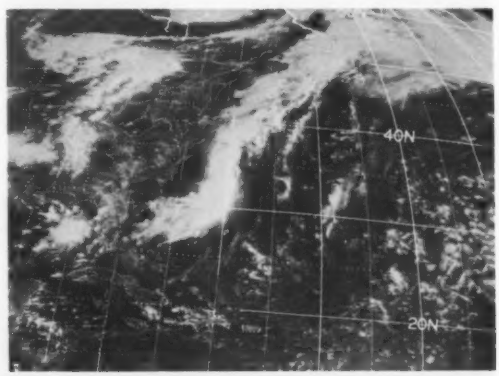

Figure 38.--Subtropical cyclone Alfa as it appeared at 1431 on the 30th. It was at this time that ship reports were so valuable in identifying the closed cyclonic circulation.

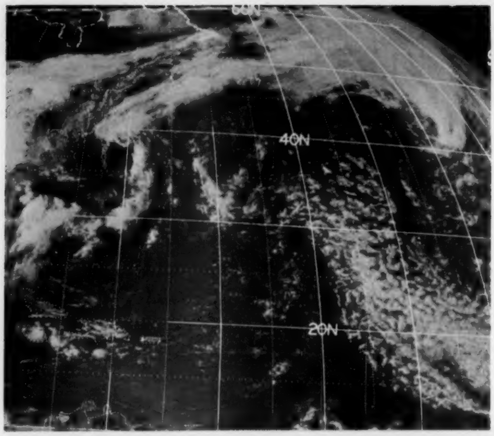

Figure 39.--At 1620 on the 31st, there is no difficulty in locating the tightly wound Alfa off New York.

central pressure of 1007 mb. By 0000 on the 2d, the storm, rapidly weakening, moved onto the coast of Maine. Six hours later, it could no longer be identified.

Reports from the following ships were directly useful in analyzing the storm: ALIAKMON, AURIVAARA, IGUAPE, IMPERIAL ST. LAWRENCE, OCEANIC, TRANSIDAHO, TRINITY, WARRIOR, and the DFQA and VSVF.

Hurricane Alice, 1973's opener, was unique because no July tropical storm or hurricane of record had ever developed or even passed through the area where Alice originated, nor had one ever passed over or near Bermuda in early July.

The origin of the storm was somewhat obscure because of the lack of upper air data in the generating area, but its creation seemed to have been the culmination of a complex set of circumstances. A week before Alice developed, a broad, flat trough of low pressure was located just off the southeastern coast of the United States, extending from the Carolina coasts southwestward over western Cuba. Satellite pictures showed considerable convective cloudiness along and east of the trough. By June 28, however,

Figure 40.--Hurricane Alice, south of Bermuda on the 3d, when she attained hurricane intensity. Bermuda is already under the influence of the cloud shield.

the trough had filled, though much of the convective cloudiness persisted while drifting eastward. While this was happening, a low-level trough in the easterlies moved westward around the southern periphery of a large anticyclone centered near 40°N, 47°W. By June 30, a closed 1012-mb LOW had developed at 26°N, 69°W, attended by a large area of convective cloudiness and cirrus, mostly south and east of the LOW's center. Alice formed and acquired storm intensity in an area where sea-surface temperatures were about 27°C (81°F).

As Alice neared tropical storm strength, satellite pictures showed the transition from a configuration in which most of the cyclonic banding was separated from the dense cloudiness, to one in which the two gradually merged.

The system was named during the evening of July 2, after reconnaissance aircraft consistently reported low-level and surface winds in excess of 34 kt, and a central pressure of 1005 mb. The storm continued to deepen and began a slow, northward movement. Hurricane-force winds and a central pressure of 1000 mb, on the morning of the 3d (fig. 40), raised Alice to hurricane status as she moved northward at 9 kt, about 160 mi south of Bermuda. The most intense phase of the storm was reached as it skirted Bermuda on the night of the 3d, when a military reconnaissance plane reported a central pressure of 986 mb and highest sustained surface winds estimated at 80 kt. After passing Bermuda, the pressure rose slightly, then remained nearly steady, until the hurricane weakened over the cold waters off the coasts of Nova Scotia and Newfoundland, on the morning of the 6th.

During its traverse northward, Alice passed near two landbased weather facilities--Bermuda and Sable Island. The lowest pressure at Bermuda was 995 mb, at 0530 on the 4th, as the center passed within 10 mi of the western tip of the island. The highest sustained surface wind reported at Bermuda was 43 kt, while gusts reached 57 kt. Sustained winds reached 65 kt, with gusts to 77 kt, atop a 100-ft tower on Bermuda.

On Sable Island (43.9°N, 60°W) the lowest pressure was 991 mb, accompanied by surface winds of 40 kt, with gusts to 57 kt, as the hurricane passed within 20 mi west of the station at 1005 on the 6th.

After passing Sable Island, Alice skirted to the east of Cape Breton Island on the morning of the 6th and made landfall over southwestern Newfoundland about 1700 that day, after having acquired a forward speed in excess of 30 kt. The hurricane merged over Newfoundland with a frontal trough moving in from the west.

Casualties--The only casualty involved the collision of the 13,554-ton Cyprian carrier FLORENCE and the 22,190-ton Liberian tanker ST. SPYRIDON in dense fog, 180 mi northeast of Quebec City, in the St. Lawrence River.

Rough Log, North Pacific Weather

June and July 1973

ROUGH LOG, JUNE 1973--The storm track pattern for the month was like a tracing of the climatological paths that was misalined, causing the tracks to be 5° latitude further south. There was even a storm track near the Bering Strait to match the climatic track. Without statistically analyzing the dates, it appears that there were more storms the last half of the month. For June, the total number was slightly above normal. In the western ocean, the majority of the storms formed in a narrow band between Kyushu and 25°N. One storm emigrated from northern Manchuria to Alaska. In midocean, the path was very diffuse between 30°N and 50°N, but east of 180° it narrows again, entering the Gulf of Alaska. One LOW got off the beaten path, and it was "California or Bust;" fortunately, it was "Bust."

The main feature of the pressure pattern was the Pacific High, in accordance with climatology. The 1025-mb High was centered near 33°N, 142°W, about 500 mi east-southeast of the normal 1023.8-mb position of 36°N, 150°W. In June, the Aleutian Low is normally a trough with an axis stretching from the Bering Sea to central India. This month there was a closed 1010-mb center in the Gulf of Alaska, near 53°N, 147°W. The area generally bounded by 40°N to 60°N and 160°W to 150°E had a very diffuse pressure pattern and flat gradient. It contained three Highs and two Lows, ranging from a maximum of 1014 mb to a minimum of 1012 mb.

There were three major areas of negative anomalies. The largest and most significant was a minus 7-mb center at 51°N, 143°W. Associated with it was a minus 5-mb in Yukon, Canada. The third was a long, narrow area that averaged 4 mb below normal. It stretched from Hai-nan Island to about 38°N, 175°W, and averaged 5° latitude in width. A 2- to 4-mb positive departure occupied the Bering Sea. Above normal pressure of 2 to 4 mb occupied a triangle in the eastern ocean, with apexes near Hawaii, Puget Sound, and an undefined point south of Baja California.

There were three tropical cyclones in the eastern North Pacific this month; hurricane Ava, tropical storm Bernice, and tropical storm Claudia. A new record was set, with no tropical cyclones in the western North Pacific since December 1972.

A large LOW was centered near 50°N, 156°W, at 0000 on the 6th. A front extended from Queen Charlotte Islands southwestward, and then westward along 35°N. On this front, a 1013-mb wave developed near 37°N, 175°W. The wave raced northeastward at about 45 kt, and was at 42.5°N, 152°W at 0000 on the 7th. The MORMACGLEN, 180 mi south of the 1008-mb wave apex, reported 35-kt southwesterly gales. The fast-moving wave continued its headlong rush until it clashed with the Coast Mountains of British Columbia at 0600 on the 8th. As the cold front passed its position, about 300 mi off Portland, the FURMAN reported moderate rain and 35-kt winds.

On that same stationary front, another wave developed at 0000 on the 7th. It, too, raced eastward, and the BUENOS AIRES MARU encountered heavy rain and

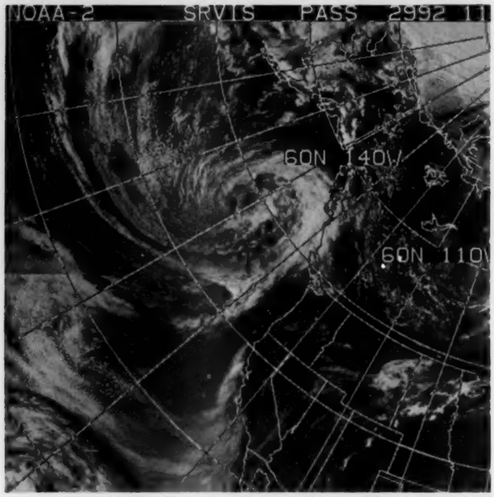

Figure 41.--Well-organized LOW approaches British Columbia, battering vessels with 45-kt winds.

35-kt gales in the warm quadrant on the 9th.

Another LOW that had moved southeastward from Kamchatka Peninsula moved in behind this LOW and slowed its advance. A third LOW developed east of the first two, and, at 1200 on the 9th, was near 42.5°N, 162°W. This last LOW moved northeastward near 49°N, 146°W at 0000 on the 11th. The NEW JERSEY MARU was suffering 35-kt northwesterly winds on her westerly course at 25 kt. She also reported 13-ft seas and swells. At 1200 (fig. 41), the LOW overtook and absorbed another LOW which was lazing along. The central pressure was now 984 mb. The PHILADELPHIA, off Vancouver Island, found 35-kt gales ahead of the warm front. On the 12th, Ocean Station Vessel "P" and another ship near 46°N, 146.5°W reported a 45-kt battering from the northwest. Late on the 12th and early on the 13th, the LOW made a small loop near 51°N, 136°W. On the 13th, the KANFOKA MARU found the highest wind reported in the storm--50 kt. This pause allowed the winds to build up the sea and swell, and the SUZUKAWA MARU, due west of the center, reported 16-ft seas and 18-ft swells. Ocean Station Vessel "P" was still receiving 40-kt gales.

The LOW slowly approached the coast of Washington State and, on the 15th, washed out against the mountains.

During this time, the pressure pattern across the North Pacific was diffuse, with numerous relatively weak HIGHS and LOWS. This 1012-mb LOW formed on the 9th in a weak circulation area between two HIGHS and a LOW. The JFLI helped the meteorologist locate it with her report of 35-kt gales.

For the next 48 hr, the LOW drifted eastward, gaining organization. At 1200 on the 11th, the LOW was at 37°N, 167.7°E. Twelve hours later, she passed under a 500-mb pressure surface trough line, and was caught up in the zonal westerlies.

The KASHU was hit by 40-kt southerly winds, west of the center, as the occluded front passed. Twenty-four hours later, at 0000 on the 13th, the 990-mb LOW was at 47.5°N, 174°W. The TOYOTA MARU No. 15, at 42.5°N, 161°W, went through a 40-kt car wash. On opposite sides of the center, the RYUSHO MARU and SHUKO MARU were lashed by 35-kt gales. Except for typhoons, this was probably the stormiest day on the North Pacific this month, at least as far as wind was concerned. Both this storm and the previous LOW had winds of 40-kt or greater on this day.

The LOW now moved into the Gulf of Alaska, towards the Olympic Peninsula, where it collapsed on the 17th.

The specific LOW of concern here formed on the 20th, but its ancestry goes back more than a week, to the 10th. A 1005-mb wave formed about 400 mi south of Kyushu, Japan. It moved northeastward very slowly until the 13th. At that time, it was about 120 mi south of Tokyo, where it turned more easterly and started to gain strength. On the 15th, the 994-mb LOW was near 39°N, 155°E and curving toward the north. Another wave moved in from the west, and the two consolidated. The GENEI MARU and the TERUKAWA MARU reported 35- and 40-kt winds on the 16th. A 1038-mb HIGH, near Adak Island, was blocking its forward movement. On the 17th, the CALIFORNIA found 35-kt gales on the east side of the LOW. During this period the forward movement was about 12 kt.

The HIGH finally started breaking down and moving southeastward on the 18th. The frontal system had moved far ahead of the parent LOW, and another LOW developed at the point of occlusion, near 49°N, 176°W. At 1200 on the 20th, the two LOWS merged near 51.5°N, 171°W at 984 mb. The CALIFORNIA, which was sailing east, was keeping ahead of the system and periodically receiving gale-force winds with a southern component. On the 21st, the strongest winds were in the northeast quadrant. Some Aleutian stations reported 35- to 40-kt winds, and the JUJU MARU No. 2 was rocked by 40-kt gales off Dutch Harbor.

The 985-mb LOW had turned southeastward as it entered the Gulf of Alaska and, at 1200 on the 22d, was at 48°N, 145°W. The OREGON MAIL, 180 mi north of the center, was bucking 45-kt bow winds. With her 20-kt speed, this meant an effective hurricane-force wind was blowing across her decks.

As several of the other storms did this month, this LOW executed a large loop. It visited the vicinity of Ocean Station "P" for 4 days (fig. 42) before heading for the coast. During this period, it gradually filled, and was a weakling of 1018 mb when it met its end near Queen Charlotte Islands.

Figure 42.--The storm center was northwest of Ocean Station Vessel "P" on the 23d, as it made a closed loop in the Gulf of Alaska.

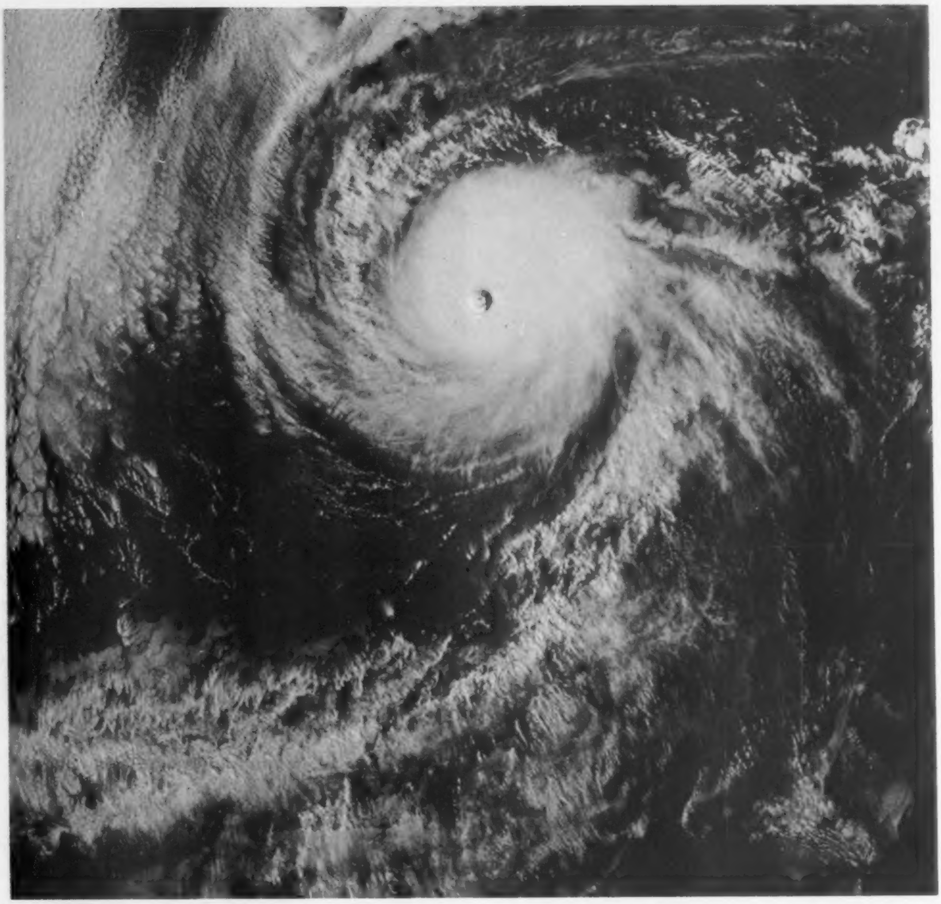

Figure 43.--This spectacular high-resolution (VHRR) picture of hurricane Ava shows the 15-mi diameter eye in detail. The soft, cotton-ball appearance hides the violent winds and seas below.

A large HIGH was developing off the Oregon coast, in the vicinity of 45°N, 145°W, as the above storm disintegrated. A tight pressure gradient developed along the coast from around San Francisco northward on the 29th and 30th. The PRESIDENT JEFFERSON ran into gale-force winds north of San Francisco as she traveled northwestward.

This was the first tropical cyclone in the North Pacific this year, and she was a beauty. Hurricane Ava was one of the most vigorous and sophisticatedly measured storms on record in the eastern North Pacific. She started as a depression on June 1, near 11.4°N, 95.4W, about 250 mi south of Salina Cruz, Mexico. The depression was nearly stationary in its formative stage, but began moving slowly westward after becoming a tropical storm at 1800 on the 2d. Ava was located by satellite and ship reports from the HOEGH TROTTER, JOSEPH LYKES, and the VOLNAY. The reports indicated the presence of a cyclonic circulation, 30-kt winds, and a pressure of 1000.6 mb about 100 mi from the center. Slow westward movement continued with intensification.

The storm became a hurricane by the afternoon of the 3d, when Air Force reconnaissance from Puerto Rico measured winds of 70 kt, with gusts to 95 kt near the center, at 12.6°N, 96.6°W, about 180 mi south of Port Angeles, Mexico. Winds reached 100 kt on the afternoon of the 5th; on the 6th, 137 kt were measured by NOAA aircraft; and Air Force radiosonde equipment, dropped into the eye, determined a central pressure of 915 mb (27.02 in), 650 mi southwest of Acapulco. At this time, the westward movement had increased to 17 kt.

Skylab passed near hurricane Ava (fig. 21), and the storm was almost directly under Satellite NOAA-2 at its peak intensity. Skylab and NOAA aircraft investigating the storm were both equipped with unique sensing devices, which enabled them to measure sea heights of 40 ft by radiometric means, the first

hurricane wave height measurement by remote sensors. The NOAA aircraft measurements also indicated how rapidly winds increased toward the eye of the storm. In 1 min, 50 sec--4 mi flight distance--winds increased from 60 to 137 kt, and in only 37 sec--a flight distance of 2 mi--winds increased from 90 to 137 kt. A circular closed-wall eye was observed by the Air Force reconnaissance crew and by the NOAA-2 satellite, as can be seen in figure 43. For additional details on these observations, see "On the Editor's Desk," page 296.

The peak intensity of the hurricane was reached on the 6th, near 11.9°N, 107.5°W, and gradual deterioration continued for the next 6 days. On the 7th, a wind of 120 kt; on the 8th, 100 kt; and on the 9th, 90 kt were measured by reconnaissance. The hurricane weakened to a 60-kt tropical storm near 16.5°N, 127°W, late on the 9th; to 40 kt on the 10th; and became a depression on the 11th. By the 12th, the remains entered the trades as an easterly wave.

Vessels whose observations aided in locating and tracking the storm were: ACAVUS, AKIBASAN MARU, ANDORA, ASHKHABAD, ATENAS, CHEVRON AMSTERDAM, CHEVRON NAPLES, CLARA MAERSK, DELTARECHT, ERISKAY, HERMAN SCHULTE, HOEGH TROTTER, HOLTEF JELL, JOSEPH LYKES, H. R. MACMILLAN, MORNING LIGHT, OAKLAND, SAN MARIN MARU, SEATTLE, SHEAF TYNE, and the WILKAWA. Others not in the AMVER listings included DAGB, DNCT, GAZG, GZSB, JDNQ, JXJT, KFGX, NKFN, and OWIE.

Tropical storm Bernice was first suggested by satellite pictures and ship reports on the 18th, 300 mi south of Ixtepec, Mexico, as a disturbance on the intertropical convergence zone. The disturbed area remained nearly stationary and increased in intensity until becoming a tropical depression at 1800 on the 21st, near 13°N, 97°W, about 180 mi southwest of Salina Cruz. Movement was toward the northwest at 10 to 12 kt.

Development to tropical storm intensity continued during the afternoon, and, by 0000 on the 22d, winds to 40 kt were estimated from satellite pictures, and a 35-kt wind was reported by the HENNITES. Movement continued northwest, with the TARONGA reporting 40-kt winds about 60 mi from the center, at 1200 on the 22d, and Acapulco, 90 mi from the center, indicating 30-kt winds. At 1800, the TARONGA reported 50-kt winds about 30 mi northwest of the center, while another vessel reported a west 40-kt wind about 50 mi southwest of Zihuantaneo, Mexico, suggesting the storm was moving onshore.

Other vessels whose observations helped locate and track the storm were: the EXPORT CHAMPION, LUDWIGSHAFEN, NORMASCAN, SANTA MARIANA, and the STAR HALMANGER. Others were somewhat remote from the center.

Tropical storm Claudia began as a disturbed area noticed on satellite pictures on the 23d, about 300 mi south of San Salvador, near 8°N, 88°W. The area moved westward at about 10 kt to 9°N, 92°W on the 24th. A closed circulation was indicated in satellite pictures, and reports by the SEUCIA, TRENTON, and the STARSTONE centered a weak depression at 10°N, 95°W, by 1800 on the 25th.

Satellite pictures indicated a more northwesterly

Figure 44.--Claudia appears as only a loosely organized cloud mass, as she prepares to dock near Acapulco. The stratus and fog along the California coast stretches for miles.

course between the 25th and 26th, and the depression intensified to a tropical storm with 50-kt winds, near 14°N, 98°W, at 1800 on the 27th. The storm continued north-northwest, but slowed to about 5 kt with maximum winds of 50-kt, until it went onshore about 30 mi east of Acapulco, late on the 28th (fig. 44).

AMVER-listed vessels aiding in locating, tracking, and estimating the intensity of Claudia were: AMERICAN LEGACY, LEMONCORE, MAURICEIN, PACIFIC ERA, SHEAF CREST, STAR COLUMBIA, STARSTONE, SUECIA, TRENTON, UNION SUNRISE, and the ZIM HAFIA.

Casualties--All casualties in the North Pacific were because of fog. The first was a collision, on the afternoon of the 5th, in Juan De Fuca Strait, between the Panamanian ORIENTAL MARINER (14,246 tons) and the Liberian WAYWAY (13,553 tons). On the 20th, the two Greek vessels MARINA L (19,566 tons) and the THEOKEETOR (10,488 tons) collided about 150 mi south of San Diego. The THEOKEETOR sank, but, happily, all of the crew was rescued by the Swedish ship SAN BRUNO. Also on the 20th, the 9,325-ton Japanese ferry MARIMO and the 300-ton fishing boat No. 15 HACHISHIO collided 12 mi off Oyaki Lighthouse. No one was injured.

A rash of collisions (3) occurred on the 29th and 30th, on the Japanese Inland Sea, in dense fog. The evenly matched 293-ton No. 8 FUJI MARU and the 293-ton No. 8 YOSHINO MARU collided near Katayama Island. The 7,017-ton ferryboat ORION collided with the 325-ton tanker SHINKO MARU, 1 mi west of Katjitorinoharu Lighthouse. None of the 294 passengers and crew were injured. The unevenly matched 4,850-ton OKUDOGO No. 2, a ferryboat, and the 48-ton YAWATA MARU, a freighter, collided off Kobe. The freighter sank, and the two crew members were rescued from their lifeboat by the crew of the ferryboat. All 187

passengers and 37 crew members on the ferry were safe.

This casualty occurred in the Arabian Sea. The Indian-registered freighter SAUDI (5,973 tons) was capsized by huge waves off the Horn of Africa on the 26th. The U. S. Navy destroyer JONAS INGRAM reported that it and the Israeli LEORA had picked up 43 survivors and 8 bodies.

ROUGH LOG, JULY 1973--Extratropical cyclone activity was at a minimum, but tropical cyclone activity was at a maximum, this month. The storm tracks followed the climatology pattern only in the broadest sense. The path with the most activity originated well east of Japan. A northern part diverted into the Bering Sea, while a secondary southern track was well south of the Gulf of Alaska. All in all, the tracks were diffuse, with no primary path.

The 1026-mb Pacific High was the dominant pressure feature. Its shape was more elongated than the 1026-mb egg-shaped climatology High. A 1011-mb LOW was centered near 47°N, 163°E. A small trough penetrated the top center of the Pacific High, south of the Alaska Peninsula. A 1003-mb LOW was centered over the Arctic Ocean near 83°N, 170°W.

The largest anomaly was a minus 8 mb, in association with the LOW over the Arctic. In the main North Pacific area, "4" was the favorite number. Two negative 4-mb anomalies were located at 45°N, 168°W and 48°N, 153°W. A positive 4-mb anomaly was centered off Portland, Oregon. A long, narrow positive anomaly extended the length of the U. S. West Coast, from Baja California to Alaska.

This month totaled 11 tropical cyclones in the North Pacific--4 in the eastern ocean and 7 in the western ocean. In the eastern area, 3 of the 4 reached hurricane strength. In the western area, 4 of the 7 reached typhoon strength. Only one other year exceeded this number of tropical storms in the North Pacific during July--1971, when 15 were recorded, 8 in the west and 7 in the east. Since 1945 only two other years have tied this number of tropical storms during July--1964 and 1972.

A new record was also set in the western North Pacific, when the first tropical cyclone of the year did not occur until Wilda formed on July 1. During an average July, tropical cyclone activity is centered on either side of the northern Philippines. In this respect, this July was average. Two typhoons and a tropical storm formed in the Philippine Sea, while two typhoons and a tropical storm developed over the South China Sea. A seventh tropical cyclone, a weak storm, formed in the mid-Pacific.

The names of the storms are as follows--eastern North Pacific: hurricanes Doreen, Emily, and Florence, and tropical storm Glenda; western North Pacific: tropical storm Wilda, typhoon Anita, typhoon Billie, tropical storm Clara, typhoon Dot, typhoon Ellen, and tropical storm Fran.

The first week of the month, only weak, diffuse extratropical Lows were present. The Pacific High was spreading and, on the 7th, covered the entire North Pacific from Japan to California, and 15°N to the Bering Strait. An old, weak front stretched from shore to shore, slightly north of the center of the HIGH.

On the 8th, a 1014-mb wave developed on the front

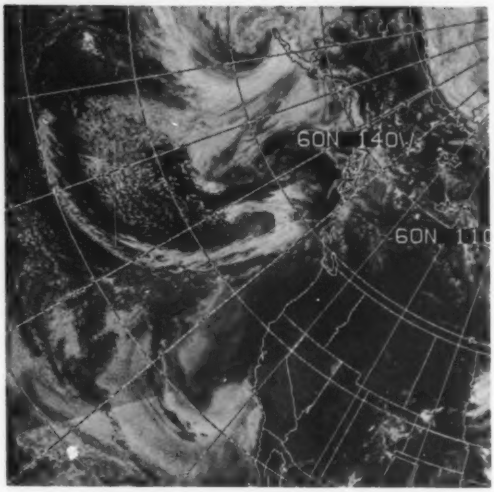

Figure 45.--The LOW with its broad cloud shield is just south of the Alaska Peninsula. The cloud pattern indicates the counterclockwise wind flow.

near 49°N, 175°E, on the northwest side of the HIGH. By 1200 on the 9th (fig. 45), the 998-mb LOW had crossed the top of the HIGH to 54.5°N, 167.5°W. King Cove, on the Alaska Peninsula, reported 35-kt gales. At this point, the storm stalled and looped around Unimak Island on the 10th and 11th. The ZAWA MARU, in the Bering Sea, found a 35-kt norther on the edge of the storm.

As the LOW came out of the loop, it moved to the southeast, as far south as 50°N, and a 1036-mb HIGH crowded closer to the California-Oregon coast. The normal summer heat LOW near the California-Nevada-Arizona border did not budge, and the winds increased off the coast. The ARGYLL reported 35-kt gales on the 11th, and the PLUTOS was windswept by 40-kt gales on the 12th. The high pressure was too much for the storm, and it again turned northeastward, dissipating over Alaska on the 13th.

Monster of the Month--This storm system was out of former tropical storm Clara, by a 1006-mb LOW to the north. On the 15th, these two produced a single 990-mb LOW near 38°N, 172.5°E. The VIVARIAS was the first to clock the young colt, at 55 kt. On the 16th, as the 982-mb LOW moved northwestward, several other touts were around the track. The TOYOTA MARU No. 18, close to the center, was whipped by 50-kt storm winds, accompanied by 16-ft seas and swells. In the grandstands (42°N, 179°W), the TAIO MARU had 40-kt gales off her port side. The LEIDENSCHAFT and the PRESIDENT MCKINLEY both rode out 35-kt winds.

The LOW was then in the process of completing a lazy "S"-shaped track, and she did the unusual by moving southwestward, then again turning to the north on the 17th and 18th. The ALEX SERAFINOVICH bucked 40-kt headwinds on her easterly course, north of the center. This backstretch of the track continued to be fast, as the HONSHU MARU and another ship reported 35- and 40-kt gales south of the Aleutians.

As the storm moved northward toward the Near Islands, its pressure started to increase and the winds decreased. By the 20th, when it circled southwest of Attu, the pressure was 998 mb and continued to increase, as it moved into the Bering Sea. On the 23d, in Bristol Bay, the old nag went to that pasture in the sky.

Late on the 21st, a ripple appeared on the polar front on the west side of the Pacific High. By midday of the 22d, it was a 998-mb LOW, at 38°N, 156°E. Early on the 23d, a second circulation started to develop in the south, as the LOW moved north, but it could not withstand the pressure of the two HIGHS on each side. The SERGEY YESENIN and another ship could attest to its presence, by the 35-kt gales they experienced.

This LOW, like others in this area, went north for the summer for cooler weather. At 1200 on the 24th, the 990-mb LOW was at 50.5°N, 165.5°E. Far to the south, the SHINTOKU MARU was rained on and blown about by 35-kt winds. As the storm center crossed into the Bering Sea, it was like the old firehorse headed for home--it sped 850 mi north-northeastward in 24 hr. On the way, it treated the Aleutians to winds up to 35 kt. As it neared the Bering Strait on the 26th it slowed to pass through the narrow strait and join an Arctic Low in the East Siberian Sea.

Wilda began the 1973 season on July 1, near 19.3°N, 118°E. This same day, she reached tropical storm strength and headed northward. Wilda's central winds swelled to 55 kt as she approached mainland China on the 2d (fig. 46). She crossed the coast south of Fu-chou. Once inland, Wilda dissipated.

While Wilda wilted, Anita blossomed in the South China Sea. By the 6th, she was a tropical storm about 80 mi off the South Vietnam coast, near 14°N. The next day she was a typhoon. Some 300 mi southeast of her center, the G8FA ran into southwesterly gales. Close to her center, winds were 75 kt, with gusts of 110 kt. Anita remained a typhoon when she crossed the coast, near Ben Thuy, on the 8th. She dissipated slowly, as she moved toward northern Laos.

The weather was quiet for a few days. On the 13th, things broke loose. The embryos of three tropical cyclones were sighted. Billie developed east of Luzon. She was a typhoon the following day, and peaked by the 15th (fig. 47). Winds of 120 kt, with 160-kt gusts, blew around a 945-mb center. The PRIBOY ran into 35-kt winds some 240 mi east of Billie's center. Miykojima, in the Ryukyu Islands, recorded 101-kt winds. On the 17th, Billie roared through the Ryukyus and into the East China Sea. She continued to weaken. On the 19th, Billie moved past Shang-hai, on a north-northwesterly course, and into the Yellow Sea.

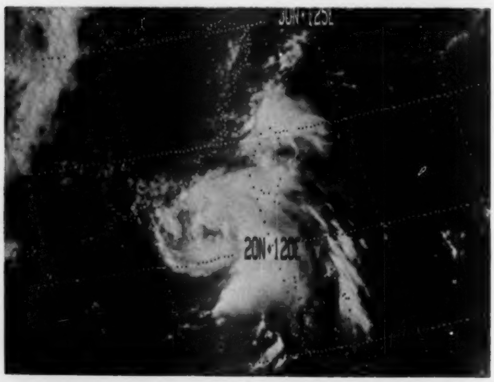

Figure 46.--Wilda at her peak on July 2. Her circulation lacked the organization for a well-developed eye.

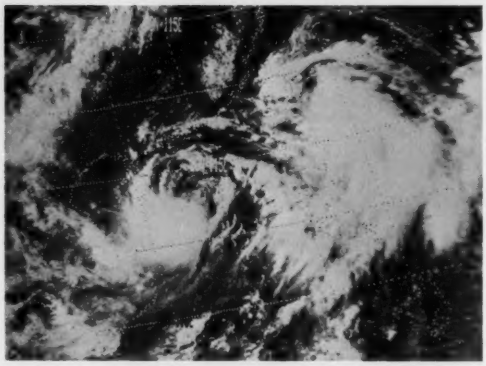

Figure 47.--Typhoon Billie is northeast of Luzon, and typhoon Dot is to the west, on July 15. Their rough seas swamped a passenger ship.

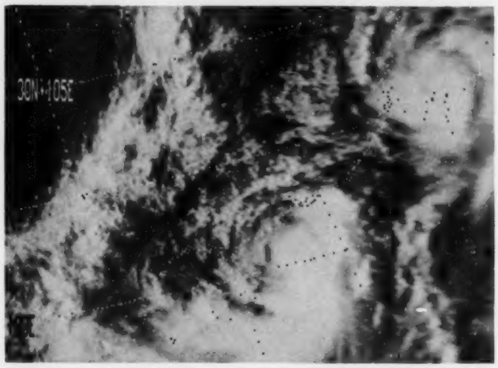

Figure 48.--On July 16, typhoon Billie is over the northern tip of Taiwan, and typhoon Dot is approaching Hong Kong, where her torrential rains caused much suffering and damage.

While Billie was bullying the Ryukyus, Dot had developed, and was threatening Hong Kong. Dot had also formed on the 13th. She had intensified quickly, and also moved northward. By the 16th (fig. 48), she was generating 80-kt winds around her center, about 150 mi east of Hai-nan. As Dot passed close to Hong Kong, her winds diminished. Her torrential rains were responsible for landslides; one woman died in a slide. Three ships ran aground in the harbor, but all were pulled free by tugs. Dot wandered across China for a few days and emerged over the East China Sea on the

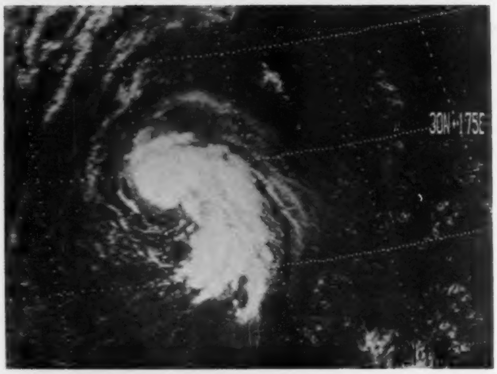

Figure 49.--Although Clara was a weak tropical storm and short-lived, this July 12 portrait shows indications of good organization and further development.

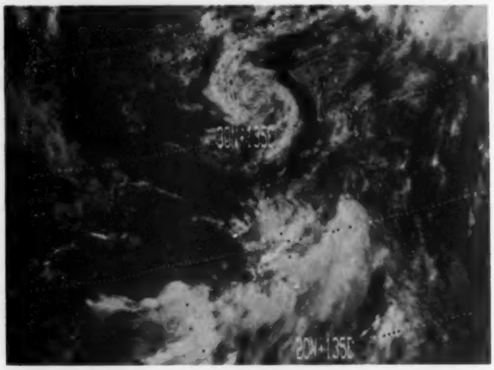

Figure 50.--Early on July 22, Ellen's shape is very much like the traditional hurricane/typhoon symbol used on weather charts. At this time, she is south of Honshu, and destined to turn west toward Kyushu.

19th. However, she never regained her former intensity.

On July 14, Billie and Dot were intensifying on either side of northern Luzon. Their circulations combined to generate rough seas in the Philippines. These seas swamped the 1,735-ton MACTAN, a domestic passenger ship. She went down in the Tablas Strait, about 120 mi southeast of Manila. Preliminary reports indicated that 645 persons survived, 2 died, and 36 were missing.

<u>Clara</u> was a short-lived tropical storm that developed on the 12th (fig. 49), around 28°N, 162°E. Winds near her center reached 35 kt on the 13th, but she started to weaken on the 14th and turned extratropical near 32°N, 161°E.

<u>Ellen</u> became the first typhoon of the season to threaten Honshu. On the 19th, she was just west of the Bonin Islands. Winds near her center were 100 kt, with gusts to 140 kt. Ellen was on a northward course that would take her directly over the Japanese mainland. Breakers of 12 ft warned Pacific coast residents of the imminent threat. Suddenly Ellen began to weaken, and she unexpectedly turned westward, less than 100 mi south of Honshu. On the 22d (fig. 50), Ellen moved across southern Kyushu as a tropical depression. She brought 1 to 4 in of rain to southern Japan, but caused little damage.

<u>Fran</u> developed on the 29th and dissipated on the 30th. She barely reached tropical storm strength just east of northern Luzon, near 19°N, 124°E. Then, she weakened rapidly.

Hurricane <u>Doreen</u> began as a disturbed area near 9°N, 101°W, over the warm water off Panama, and was first seen by satellite, at 1600 on July 16. The area was in the intertropical convergence zone and showed some signs of a closed circulation. A nighttime infrared photograph, at 0400 on the 17th, showed the area was moving west at 10 kt and becoming organized. By 1800, satellite pictures placed the center of circulation near 9°N, 105°W, but reports from the KAPAA, HOEGH DYKE, and the AKADEMIC KOROLYOV indicated that the center was some 2° farther north. By this time, a tropical depression had formed, and bulletins were issued.

Development was rapid, with the AKADEMIC KOROLYOV reporting 30-kt winds at 0000 on the 18th, suggesting that a tropical storm had formed near 10.5°N, 107°W, about 120 mi east of Clipperton Island. An 0600 report was received from WHQS, a non-AMVER-listed vessel, and 0600 and 0900 observations were received from the SHAMALY. An Air Force reconnaissance aircraft measured 60-kt winds at 2230 on the 18th, and at the rate of development taking place, the storm was indicated as a hurricane at 0000 on the 19th.

The hurricane was moving west-northwestward at about 12 kt. The AMERICAN CHALLENGER passed to the south during the night of the 18th. The HOEGH DYKE, heading west, passed in front of the storm between 1800 and 2100 on the 19th, reporting 40-kt winds. The SPEY BRIDGE also reported 40-kt winds. Both vessels were about 150 mi from the center. Reconnaissance aircraft at that time measured winds of 90 kt, with a central pressure of 973 mb.

Doreen continued on her course, well out of range of surface vessels. Aircraft reported maximum intensity winds of 120 kt at 1920 on the 20th (fig. 51); 80 kt

Figure 51.--Hurricane Doreen is near 14°N, 122°W, at 1747 July 20. At this time, her maximum winds are 120 kt.

at 1906 on the 21st; 65 kt at 1825 on the 22d; and 60 kt at 1800 on the 23d, near 15°N, 133°W. Reconnaissance priority after the 23d was directed toward hurricane Emily, nearer to the more heavily traveled shipping lanes of Manzanillo.

Wind speeds in the storm were in the 55- to 70-kt range after 1800 on the 23d. Doreen passed 17°N, 140°W, on a westerly course, shortly before 1800 on the 25th.

A frontal system between two portions of the North Pacific high-pressure area weakened as Doreen approached 145°W, and the two cells merged with the main center about 1,000 mi northwest of Honolulu. The main High center moved eastward, forcing Doreen southward on the 27th, to near 12.5°N, 150°W at 1800 on the 28th, after which she set a west-northwesterly course, at 8- to 10 kt.

On the afternoon of the 27th, the 144-ft Greek ship CORNELIA sailed into the storm's path and sent out an emergency call for help when it lost its rudder, while being lashed by 52-kt winds and 35-ft waves. A sea-level pressure of 971 mb was reported. The ship managed to clear the storm and continued its way to Panama, after deciding not to return to Honolulu with Coast Guard assistance.

Before the dip to more southern latitudes, Doreen was classed as a tropical storm, but regeneration developed hurricane winds again at 0000 on the 28th, which continued until 0600 on August 1. The hurricane passed 300 mi south-southwest of South Point, Hawaii on the afternoon of the 30th. On the afternoon of the 29th, 9-ft ocean swells and 3 1/2-ft surf generated by Doreen were observed at Kapoho, the easternmost point of the island of Hawaii.

West of 165°W, deterioration of the storm was rapid. Winds decreased to 60 kt near 18°N, 166°W, at 1200 on August 1; to 35 kt at 20°N, 171°W, at 1200 on the 2d; and, at 0000 on the 3d, the storm was a depression with 30-kt winds. Advisories were discontinued, and she dissipated in an upper air trough as she crossed the Dateline.

Doreen was an interesting storm. The sharp recurvature on the 27th and 28th, and the subsequent redevelopment to hurricane intensity, were unusual. She had a long life--18 days, covering a distance of 4,200 mi. She was well-behaved--except for the redevelopment period on the 27th, she followed the forecast track. Throughout her life cycle, Doreen followed a strikingly similar path to that of hurricane Celeste in August 1972.

Squally weather and 40-kt winds in the Gulf of Tehuantepec, beginning July 18, were reported by the ROSEVILLE. The RUTH LYKES reported 30-kt winds. The squalls gradually organized into a cyclonic circulation and formed a tropical depression near 13°N, 96°W, at 0600 on July 21.

The squally area was nearly stationary; but, as it organized, it began moving west-northwestward at 12 kt, becoming tropical storm Emily near 14°N, 99°W, at 1800 on the 21st. Winds increased to hurricane force by 0600 on the 22d. Winds of 40 kt were reported 120 mi from the center by the EXPORT COMMERCE, the VAR, and the TAIAN, at 0600 on the 22d.

Emily ran west-northwestward, nearly parallel to the coast and 180 mi offshore, until south of Manzanillo, where she turned to a more westerly course, leaving the heavily traveled shipping lanes. She developed 110-kt winds at 1755 on the 22d, near 15°N, 104°W,

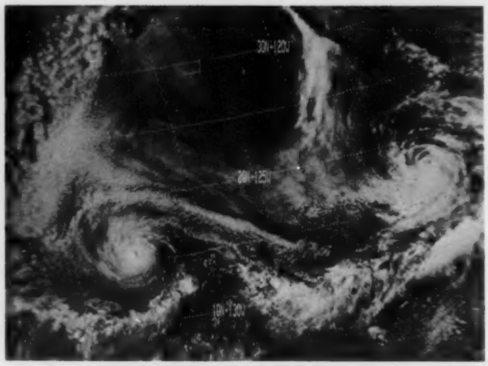

Figure 52.--Hurricane Emily, near 17°N, 113°W, and hurricane Doreen, near 16°N, 136°W, at 1736 July 24, were sisters, but not identical twins. Their maximum wind speeds were within 10 kt, but Doreen has a more orderly circulation.

and 90-kt winds at 17°N, 108°W, on the 23d, as measured by Air Force reconnaissance planes. Gale winds were reported off the coast of Mexico, more than 300 mi to the east, between the 22d and 24th (fig. 52). These reports came from the ANTARCTIC CORE, EXPORT COMMERCE, HOEGH MARLIN, POMONA, TAEPING, TAIAN, and the VAR, and non-AMVER-listed vessels GLBF, ICKN, SYWG, and 4XMY. Satellite pictures indicated that Emily maintained hurricane intensity through 1200 on the 25th, then near 17.5°N, 114.5°W.

Gradual weakening then took place, with the tropical storm curving toward the northwest, until winds reached 35 kt. This strength was maintained for about 36 hr, until the center reached 22°N, 123°W, at 0000 on the 28th. Thereafter, remains of the storm were indicated in satellite pictures, and the cloudiness moved northwestward to 25°N, 125°W by August 6, before being absorbed into the northeast trades.

A disturbed area, 150 mi off Guatemala on the 25th, was moving slowly west-northwestward, curving a little toward the coast. The area was slow to develop; but, at 0600 on the 26th, the LABRADOR CLIPPER and the UNION EAST reported 30- and 35-kt winds, respectively, and indicated a cyclonic circulation about 75 mi southeast of Acapulco (fig. 53).

By 0000 on the 27th, reports from the ARCO COLUMBIA, GOTAMA JAYANTI, SHIRLEY LYKES, and VARICELLA indicated that the greatest activity had moved to about 100 mi south of Acapulco, with a circulation strong enough to indicate a tropical storm. A westward movement continued through the night of the 28th, as the storm slowly increased, becoming hurricane Florence at 0000 on the 29th, near 17°N, 108°W, about 200 mi southwest of Cape Corientes.

The hurricane continued west-northwestward until 2150 on the 28th, when winds reached an estimated 80 kt, according to satellite pictures. A pressure of 990 mb was measured by reconnaissance aircraft. As the storm moved over cooler waters and into more stable air from the north, dissipation was completed in less than 24 hr, near 20.5°N, 115.5°W, by 1800 on the 30th.

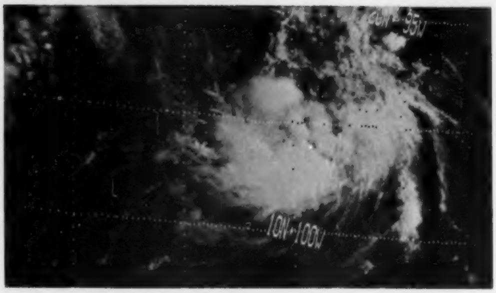

Figure 53.--The beginning of hurricane Florence, at 1536 on July 26, while still a tropical depression. Even at this time, cyclonic cloud bands lead into the weak circulation.

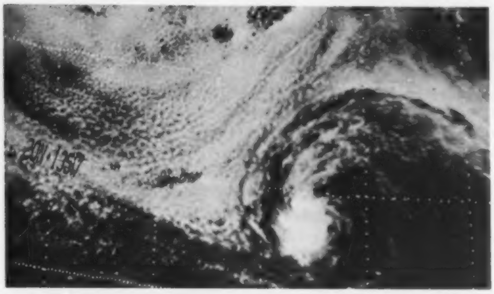

Figure 54.--Tropical storm Glenda, at 1805 on August 4, 5 min after the TOYOTA MARU reported 40-kt winds, indicating she was still at tropical storm strength.

Glenda developed slowly, about 300 mi off the coast of Guatemala. As a tropical disturbance, she moved west at about 12 kt, until south of Acapulco, when a closed circulation was inferred from nighttime satellite pictures, at about 0400, July 30.

At 1800 on the 30th, the MALLORY LYKES reported squalls and southerly 30-kt winds about 75 mi east of the center, and the NISSAN MARU, a north wind of 10 kt, 180 mi west of the center. An advisory was issued for a tropical storm, with winds to 40 kt, heading west-northwestward at 12 kt.

This direction of movement and speed continued through 1800 on the 5th. Winds increased to 50 kt during the night of the 31st, then decreased to the 30-kt winds of a tropical depression at 1800 on the 1st. It maintained 30-kt winds through 1200 on the 4th, near 18°N, 123°W. The TOYOTA MARU reported 40-kt winds, with a 989.3-mb pressure, at 1800, indicating that a tropical storm was still in progress (fig. 54). This intensity continued until 1800 on the 5th, when satellite pictures showed cool air entering the dissipating system.

Few ships reported weather in the vicinity of Glenda, through most of her life. Positions were largely based on visual and infrared satellite pictures, at about 1800 and 0500, respectively.

A correlation of eastern North Pacific storm intensity with satellite pictures is a continuing program that can only be successful if vessels experiencing storm conditions send weather reports to "METEO WASHDC." Use the preferred format, preceded by the word "STORM."

Casualties--The 1,215-ton Japanese ferry MURORAN MARU and the 4,736-ton Philippine cargo ship SANTA ANA collided in fog on the 1st, in Tsugaru Strait, with no injuries. The Panamanian-registered motorship EASTERN DIAMOND (8,213 tons) developed a 30° list after a collision with the Japanese-flag ore carrier RYUSHO MARU (11,612 tons) in thick fog, 680 mi east of Nemuro, Japan. The Russian trawler NAKHODKA (3,170 tons) required repairs to her bow after a collision with her sister ship, the SEZD ULKSM (278 ft), which sank. One hundred and fifty were reported rescued.

Marine Weather Diary

NORTH ATLANTIC, SEPTEMBER

WEATHER. With the approach of autumn, subdued weather conditions that characterize the summer season over the higher latitudes gradually give way to increased cyclonic activity resulting from moderate intrusions of colder air. The Icelandic Low deepens to about 1006 mb, and is centered roughly halfway between Iceland and southern Greenland. The Azores High (1021 mb), centered near 33°N, 40°W, is a little weaker than in August.

WINDS. Almost without exception, the prevailing winds are westerly between 40° and 60° N. However, over the Grand Banks and the waters east of there to about 40° W. southerly winds prevail, and winds are variable south of Nova Scotia and over the Bay of Biscay. Speeds across this latitudinal belt are generally about force 4. South of 40°N, somewhat lighter winds average about force 3. Wind directions are frequently variable between 30° and 40°N, along the axis of the subtropical High, but northerlies dominate between 20° W and the Strait of Gibraltar. Between 30° and 10°N, easterly winds predominate over the western ocean (northeasterly over the Caribbean Sea) and northeasterly winds are the rule over eastern waters. Northwesterly winds blow over the Mediterranean, and southeasterlies are common over the extreme southern North Atlantic. Northerly winds prevail south of the Denmark Strait while southwesterlies predominate over the Norwegian Sea. Northwesterly and southeasterly winds are most common over the southern approaches to the Davis Strait. Wind speeds north of 60° N average force 4 east of Greenland, but near the Davis Strait more reports of force 2 winds are received than of any other speed group.

GALES. The frequency of gales increases in September, particularly over northern latitudes. Frequencies of 10 percent are found just south of Greenland's southern tip, over the open waters between northern Labrador-

southern Baffin Island and southwestern Greenland, over the Norwegian Sea, and over the waters north and south of Iceland. The highest frequency, 20 percent, is found over waters well north of Iceland and over a portion of the Norwegian Sea. Elsewhere, 5-percent frequencies are fairly common north of 50° N. South of 40°N, gales are unlikely to be encountered except in storms of tropical origin.

EXTRATROPICAL CYCLONES are more frequent than in August, and occasional severe storms may be encountered. Primary storm tracks lead northeastward from the waters off Labrador and Newfoundland to southern Iceland and then over the Norwegian Sea. Another major storm track enters the Davis Strait from the Hudson Bay-northern Quebec region, while a third advances up the Baltic Sea from southern Scandinavia into Russia. One secondary storm track crosses the Straits of Mackinac on its way from the Great Plains to the primary track over Labrador.

TROPICAL CYCLONES. Tropical storm activity reaches a peak in September. From 1931 to 1972, 141 tropical storms have originated in September and 89 of these has reached hurricane intensity. As many as seven tropical storms were reported in September (1949), while in 1930 there were none. The entire western ocean is subject to these storms, many of which originate east of the West Indies and move westward over or north of these islands either to enter the Gulf of Mexico, or to recurve northeastward over western waters. Some storms entering the Gulf recurve over Florida and often parallel the U.S. east coast. Another breeding ground for tropical cyclones is over the Caribbean, east of Nicaragua. Many tropical storms or hurricanes are still packing considerable punch when they reach northern shipping routes.

SEA HEIGHTS of 12 ft or more have a frequency of 10 percent or higher over most of the North Atlantic between 50° and 65°N, while small areas of 20-percent frequency occur off Greenland's southern tip and over the Denmark Strait.

VISIBILITY. Percentage frequencies of visibility less than 2 mi exceed 10 percent north of a line drawn from the western Labrador Sea eastward to 57°N, 48°W, and then southwestward to encompass all of Newfoundland and the Grand Banks. From there, the line extends north-northeastward to the waters south of the Denmark Strait and then eastward, barely missing the southern tip of Iceland, before dipping southeastward to include the Pentland Firth and the Hebrides. The line then passes east of the Shetland Islands before entering the Norwegian Sea midway between Iceland and Norway. Percentage frequencies of visibility less than 2 mi decrease to less than 10 percent over the central and northern portions of the Davis Strait, but increase to more than 20 percent over the northern reaches of the Labrador Sea above 60°N, and over the waters north of Iceland, east of the Denmark Strait. Over a small portion of the latter area near 69°N, 16°W, the percentage frequency of visibility less than 2 mi exceeds 30 percent.

NORTH PACIFIC, SEPTEMBER

WEATHER over the North Pacific continues to be generally pleasant in early September but, as the month advances, early winter-type storms occur over the northern shipping lanes. Western portions of these routes are also subject to tropical cyclones. A closed Aleutian Low reappears in September, centered over southwest Alaska with a central pressure of 1007 mb. The 1021-mb subtropical High, near 36°N, 146°W, has weakened considerably and is centered about 300 mi southeast of its August location.

WINDS. The summer winds of July and August start to undergo modification in September. Between 40° and 60°N, westerly winds of force 4 prevail over the waters between 160° E and 150°W, but over the Bering Sea northwesterlies are predominant. East of 150°W, winds tend to blow more from a southwesterly direction except close to the coast of the conterminous United States where northerly winds are general and over the Gulf of Alaska where easterly winds prevail. West of 160°E, force 4 winds enter the area from the southwest. North of 60°N, northerly winds (force 4) are likely to be encountered. South of 40°N, force 3-4 winds are most common, and the "northeast trades" prevail over most of the waters between the Equator and about 35° N. Winds from the southerly quarter still predominate east of Honshu. Near the Asiatic 3 to 4 winds are most common, and the "northeast trades" prevail over most of the waters between the Equator and about 35° N. Winds from the southerly quarter still predominate east of Honshu. Near the Asiatic mainland, a change to the winter (northeast) monsoon is in progress except over the South China Sea and the waters east of the Philippines where southwesterlies still flourish. Out from the Gulf of Tehuantepec, winds are quite variable, although those from the southerly quarter are least likely to be observed.

GALES. Winds of 34 kt or higher are encountered between 5 and 10 percent of the time over much of the open Pacific north of about 45° to 50° N over eastern waters and between about 37° and 45° N over western waters. A typhoon-influenced area of frequencies greater than 5 percent extends from the East China Sea to the Philippine Sea.

EXTRATROPICAL CYCLONES. Well-developed extratropical storms occur more frequently in September than in August. Most of these move northeastward from the Japanese Islands to pass over southwestern Alaska. Others enter the Gulf of Alaska from the waters south of the eastern Aleutians. Storm tracks are displaced southeastward from those of August.

TROPICAL CYCLONES. On the average, four or five tropical storms can be expected in the western North Pacific in September, almost as many as in August. About three of these will achieve typhoon strength. These storms usually originate in the lower latitudes west of about 150°E, and initially move west-northwestward. Some travel across the northern Philippines and the South China Sea, while others recurve in the vicinity of the Philippine Sea to pass over or near the Japanese Islands.

About three tropical storms will whirl off the Mexican coast in any given September. One or sometimes two will usually become a hurricane. These storms either originate over the waters off southern Mexico and move northwestward parallel to the coast

(and sometimes inland), or they develop near the Revillagigedo Islands and move westward out over the open ocean.

SEA HEIGHTS of 12 ft or more are common 2 to 10 percent of the time north of about 35°N over eastern waters and north of about 30°N over western waters (excluding the Bering Sea)--as well as over the South and East China Seas, the Gulf of Tehuantepec, and the lower Gulf of California. Two areas of maximum frequency greater than 10 percent are located within an elliptically shaped area between 46° and 50°N and 162° and 179°E, and over the Okhotsk Basin.

VISIBILITY. Fog is less prevalent in September than in August, but it is still frequent north of about 40°N. Frequencies of 10 percent or more of visibility less than 2 mi are common over the waters between 40°N and the Bering Strait, west of 145°W and east of 150°E. However, the Alaska Peninsula and the Gulf of Alaska, included within the above area, host frequencies of less than 10 percent. A region of frequencies greater than 20 percent surrounds the waters of southern Kamchatka southwestward to the central Kurils, then eastward to Ostrov Beringa.

NORTH ATLANTIC, OCTOBER

WEATHER. Storms in the middle and higher latitudes increase in frequency and energy during October. The westerlies have pushed southward, and the 1002-mb Icelandic Low, centered about midway between Iceland and southern Greenland, is stronger than it was in September. The Azores High, centered near 34°N, 35°W, is only slightly weaker (at 1020 mb) than in the preceding month, but it has diminished in size.

WINDS. North of 40°N, prevailing winds are westerly (generally of force 4 to 6 north of 50°N and 3 to 5 between 40° and 50°N), except over the Norwegian Sea where southerlies dominate; the North Sea, Baltic Sea, and some other eastern waters which host southwesterlies; the area near the Icelandic Low where winds are variable; and an area southeast of the Davis Strait which has a preponderance of light (force 2) northerlies and southeasterlies. South of the 40° line, northeasterly winds are prevalent (about force 3). Southeasterly force 3 winds blow near the Equator between South America and Africa. Northwesterly winds, force 2 to 3, generally prevail over the Mediterranean Sea.

GALES. Both the frequency of and the area subject to gales increase markedly over the previous few months. Winds of force 8 or more can be expected oceanwide north of about 40°N, with a frequency from 5 to over 20 percent. The highest frequencies occur over a small area south of Greenland's southern tip, the Greenland Sea, and the northern portion of the Norwegian Sea. An analysis of eight Ocean Station Vessels north of 40°N indicates that gales generally last less than 1 day over these waters.

EXTRATROPICAL CYCLONES. The temperature contrast off the Atlantic coast, from Labrador through the Carolinas, is conducive to cyclogenesis. Other principal areas of cyclogenesis lie over midocean within an egg-shaped area oriented in a northeast-southwest fashion and comprising a 250- to 300-mi-wide area between 56°N, 23°W and 48°N, 37°W; over the Bay of Biscay; within the coastal area from Marseille east-southeastward to Naples; over all but the extreme southern part of the Adriatic Sea; over the Skagerrak, the Kattegat, and the Baltic Sea to about 61°N; off the northern Norwegian coast; east of Iceland; and off the Denmark Strait coast of Greenland. There are more extratropical cyclones than in September, but primary storm tracks are similar, although most are displaced a little farther south. The secondary cyclone track over the northwestern Mediterranean area has lengthened and become of primary importance. Primary tracks are also found over North America from Kansas across the Great Lakes to James Bay and from James Bay to the Labrador coast. Portions of the Scandinavian track and the midocean track toward southern Iceland have less cyclone activity than in September. Occasionally North Atlantic extratropical storms, being of considerable intensity, generate hurricane or near-hurricane-force winds.

TROPICAL CYCLONES. The hurricane season continues into October, but after the middle of the month, the probability of a tropical storm occurrence diminishes rapidly. Since 1931, 77 tropical storms have popped up over the North Atlantic, and 53 percent of these have become hurricanes--a smaller percentage than in August or September. The great majority of the 77 storms developed before the 21st of the month. Most October storms form over the western Caribbean, but some are spawned near the Lesser Antilles. Recurvature usually takes place farther south and east than in September.

SEA HEIGHTS. During October, sea heights of 12 ft or more are usually encountered 10 percent or more of the time over the open ocean north of about 40°N (excluding most of the Norwegian Sea), over the Gulf of Lions, and over central Hudson Bay. An area of 20-percent frequency extends southward from the Denmark Strait to between 55° and 62°N, then east and west over the waters south of Iceland and Greenland. A second, much smaller area is centered near 50°N, 40°W.

VISIBILITY continues to improve during October compared with the previous month. Frequencies of 10 percent or more of visibility less than 2 mi are now found in only three scattered areas--the southern Davis Strait and northern Labrador Sea, over waters due east of Newfoundland, and from the southern reaches of the Denmark Strait southeastward to the Faeroe Islands and then north-northeastward to the Greenland Sea. As in September, the cold waters north of Iceland entertain an area of 20- to 30-percent frequency of visibility less than 2 mi and a small area (within this larger area and centered near 68°N, 18°W) where visibility less than 2 mi exceeds 30 percent of all observations.

NORTH PACIFIC, OCTOBER

WEATHER. October marks the transition to winter conditions over the northern latitudes of the North Pacific. The Aleutian Low lying off Cape Newenham, Alaska, has deepened 4.5 mb (as compared to September) to 1002.5 mb, while the subtropical High has become a flat east-west ridge, centered roughly along the 33d parallel, containing a maximum pressure of about 1020 mb.

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WINDS. Between 40° and 60°N, westerly winds predominate with forces 4 to 6 most frequent. However, northwesterlies and northerlies prevail over the eastern Bering Sea, easterlies dominate the Gulf of Alaska, and winds off the coast of British Columbia normally blow from the southwesterly quarter. North of 60°N, conditions are relatively unchanged compared with those of the preceding month. From 30° to 40°N, directions are more variable with northeasterly and northerly winds prevalent east of Honshu and northwesterlies common east of the dateline, shifting to northerly near the California coast. Force 4 winds constitute the largest percentage frequency within the above latitudinal belt. The "northeast trades" (averaging slightly less than force 4) prevail between the Equator and 30° N. Northerly force 3 winds are the general rule out from the Gulf of Tehuantepec. The winter monsoon is now well established over Asiatic waters, penetrating as far south as Indochina.

GALES. The chances of encountering winds of force 8 or higher increase appreciably in October, particularly in the middle and higher latitudes. The highest incidence of gales occurs between 48° and 56°N, from Kamchatka eastward to about 140°W, with 10 to 20 percent of the wind observations over most of these waters revealing gales. Ships plying the central Bering Sea as far north as the 63d parallel are also laced by gale-force winds more than 10 percent of the time. There is a gradual decrease in frequency southward--gales are infrequent south of 30° N over the central ocean, 35° N over the western ocean, and about 44° N above eastern waters. Nevertheless, gales are observed between 5 and 10 percent of the time over the typhoon-troubled waters near Taiwan and those southwest of Japan.

EXTRATROPICAL CYCLONES. The frequency and intensity of extratropical cyclones increase in October. A principal area of cyclogenesis lies within a large region surrounding the Liaotung Peninsula (mainland China), Korea, the northern Ryukyus, all of Japan (including the Sea of Japan), and most of Sakhalin. In some places north of 40°N, this area extends as far east as 160° E. Other major regions of cyclogenesis are situated over the Gulf of Alaska, off the coast of British Columbia and the U.S. Pacific Northwest, and over a fairly large eastern ocean area centered about midway between the Alaska Peninsula and the Hawaiian Islands. Primary storm tracks over central and eastern waters now extend along the Aleutian chain to the Gulf of Alaska or arrive in the Gulf after following a more northeasterly path. Over western waters, storms reach the western Aleutians either by passing over Sakhalin and lower Kamchatka or by developing strength east of Japan.

TROPICAL CYCLONES. Three or four tropical storms can be expected to develop over the tropical waters of the Far East. On the average, two or three reach typhoon intensity. Most of these tropical cyclones form at low latitudes in an area extending from the Philippine Islands to about 155° E. Their early movement is generally west-northwestward, and most recurve east of the Philippines or Taiwan and sweep up along the east coast of Japan. A smaller number move across the Philippines into the South China Sea; a still smaller number reach the Asiatic mainland.

In the tropical waters of the eastern North Pacific, tropical cyclones are less frequent than in September, averaging about two per year. Roughly half of these storms reach hurricane intensity at some time in their lives. October tropical cyclones follow less regular tracks than those of September. After developing off the coast of southern Mexico-Guatemala or near the Revillagigedo Islands, a large percentage of these storms will move inland over Mexico south of about 30°N.

SEA HEIGHTS of 12 ft or more affect the same general areas as in September, but frequencies greater than 10 percent are much more common over the northern shipping lanes, covering an area extending from about 140° W to 160° E and from the Aleutians southward to about 45° N. The area over the lower Gulf of California with frequencies of 2 to 10 percent is no longer present, but a new quite small area appears near 13° N, 145°W.

VISIBILITY. Percentage frequencies of low visibility decrease in October. Visibility less than 2 mi occurs 10 percent or more of the time north of a line drawn from Ostrov Karaginski eastward to a point northeast of the Pribilofs and then southwestward across the Fox Islands to a point near 42°N, 175°W. From there, the line extends eastward across the 155th meridian and then northward to Kodiak Island.